



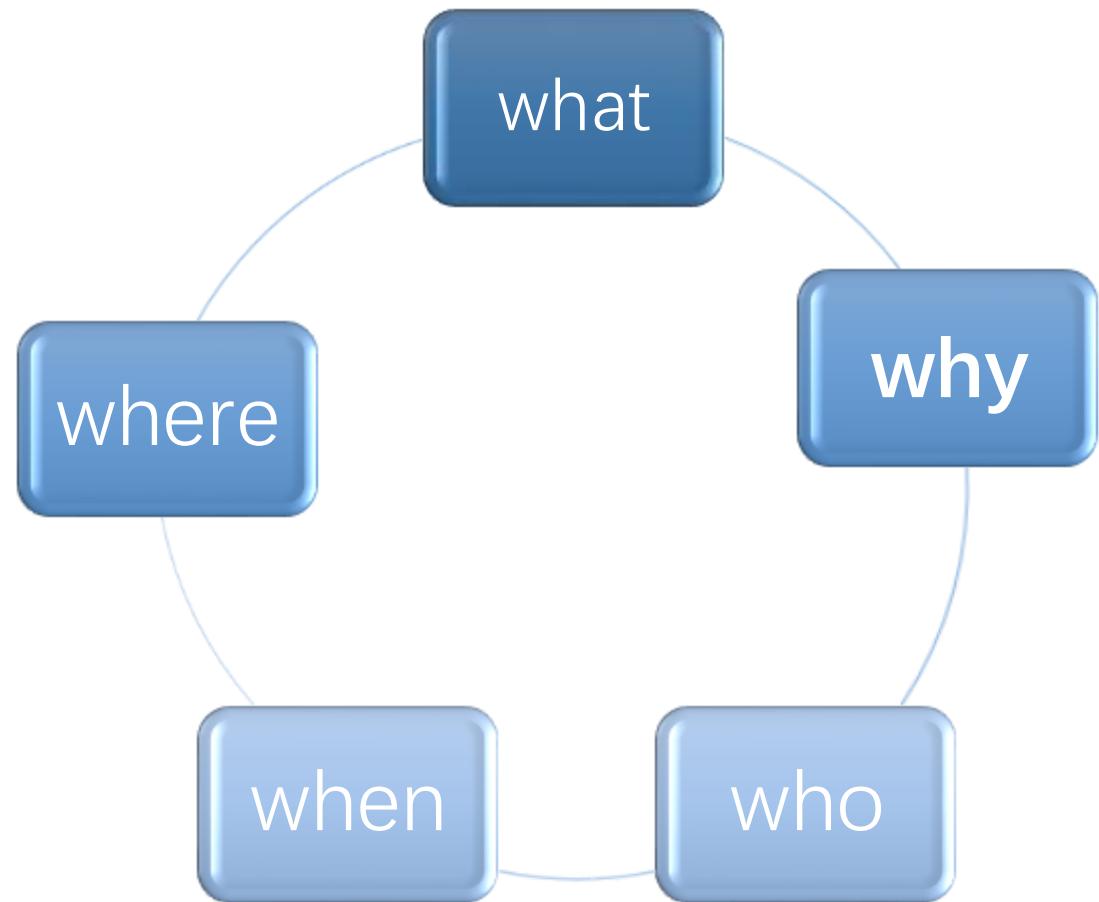
ECMO for MBBS

华中科技大学同济医学院附属同济医院ICU 严丽

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内 容



how the ECMO come to us

Lung Failure



Gas exchanger

Pump Failure



Pump

RESPIRATORY FAILURE

PUMP FAILURE - HYPERCAPNIC



Fig. 1 A young patient with poliomyelitis being manually ventilated by a medical student during the poliomyelitis epidemic in Copenhagen, 1953 [Source: Medical History Museum in Copenhagen]

RESPIRATORY FAILURE

PUMP FAILURE - HYPERCAPNIC

LUNG FAILURE - HYPOXEMIC



**ACUTE RESPIRATORY DISTRESS
IN ADULTS**

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The Lancet · Saturday 12 August 1967

**ACUTE RESPIRATORY DISTRESS
IN ADULTS**

DAVID G. ASHBAUGH
M.D. Ohio State

- The syndrome did not respond to usual and ordinary methods of respiratory therapy:

Ventilator + Oxygen

The Lancet · Saturday 12 August 1967

**ACUTE RESPIRATORY DISTRESS
IN ADULTS**

DAVID G. ASHBAUGH

- The syndrome did **not** respond to usual and ordinary methods of respiratory therapy
- Positive end-expiratory pressure (PEEP) **was most helpful in combating atelectasis and hypoxemia**

RESPIRATORY FAILURE

- Oxygen
- PEEP
- Lung protective ventilation
- ↓ dead space
- Prone position
- Recruitment maneuvers
- iNO
- Maintaining spontaneous breathing

LUNG FAILURE: HYPOXEMIC (+ HYPERCAPNIC)



OPTIMAL / MAXIMAL EXPLOITMENT
OF THE FAILING ORGAN

The going gets tough

- the artificial pump is not enough
 - Severe HYPERCAPNIA
 - Dangerous HYPOXEMIA

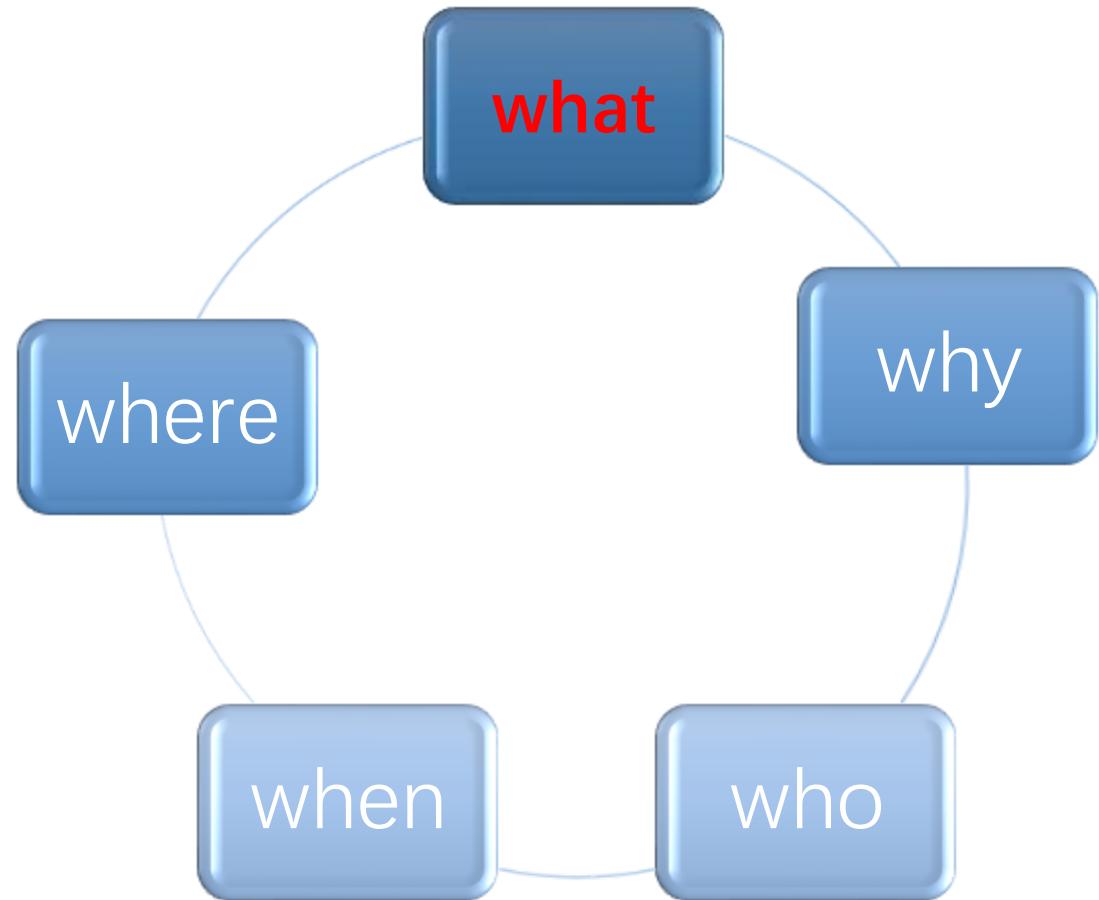
Extracorporeal membrane oxygenation in severe acute respiratory failure. A randomized prospective study.

[Zapol WM](#), [Snider MT](#), [Hill JD](#), [Fallat RJ](#), [Bartlett RH](#), [Edmunds LH](#),
[Morris AH](#), [Peirce EC 2nd](#), [Thomas AN](#), [Proctor HJ](#), [Drinker PA](#), [Pratt PC](#), [Bagniewski A](#), [Miller RG Jr.](#)



Nine medical centers collaborated in a prospective randomized study to evaluate prolonged extracorporeal membrane oxygenation (ECMO) as a therapy for severe acute respiratory failure (ARF). Ninety adult patients were selected by common criteria of arterial hypoxemia and treated with either conventional mechanical ventilation (48 patients) or mechanical ventilation supplemented with partial venoarterial bypass (42 patients). Four patients in each group survived. The majority of patients suffered acute bacterial or viral pneumonia (57%). All nine patients with pulmonary embolism and six patients with posttraumatic acute respiratory failure died. The majority of patients died of progressive reduction of transpulmonary gas exchange and decreased compliance due to diffuse pulmonary inflammation, necrosis, and fibrosis. **We conclude that ECMO can support respiratory gas exchange but did not increase the probability of long-term survival in patients with severe ARF.**

内 容

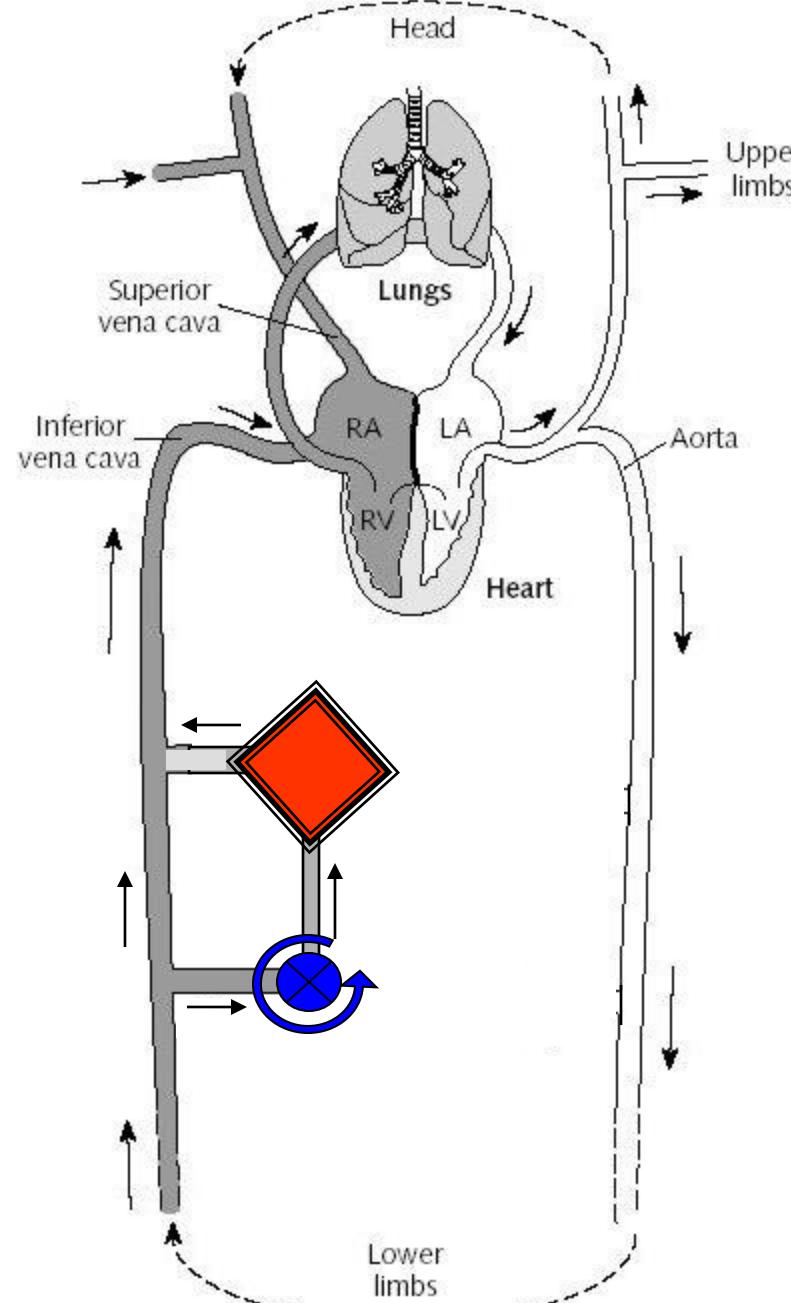


how the ECMO works

vv ECMO (respiratory ECMO)

CO₂ removal

Oxygenation



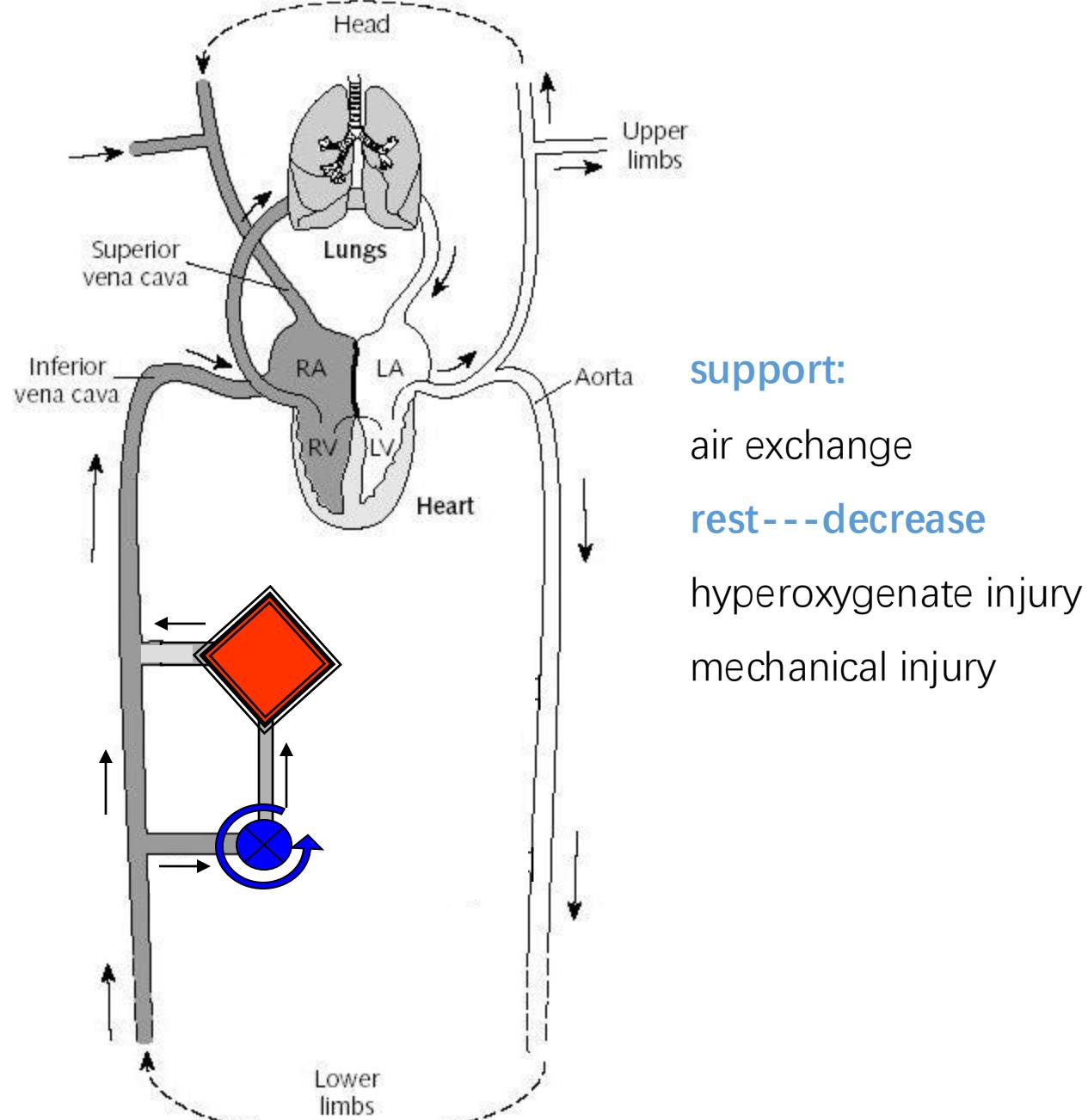
vv ECMO (respiratory ECMO)

CO₂ removal

it mainly depends on artificial
lung ventilation
(gas flow)

Oxygenation

it mainly depends on artificial
lung perfusion
(blood flow)



support:

air exchange

rest---decrease

hyperoxygenate injury

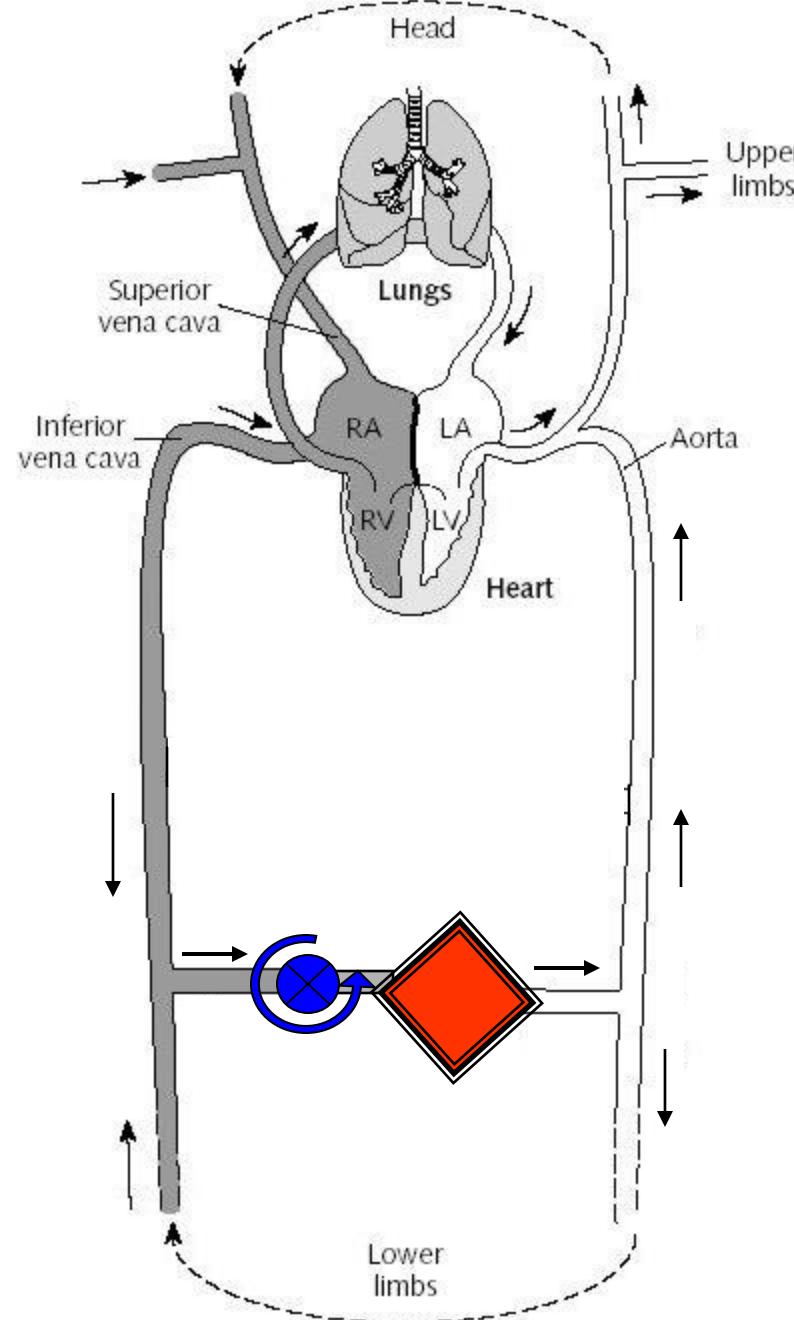
mechanical injury

va ECMO (cardiac ECMO)

CO₂ removal

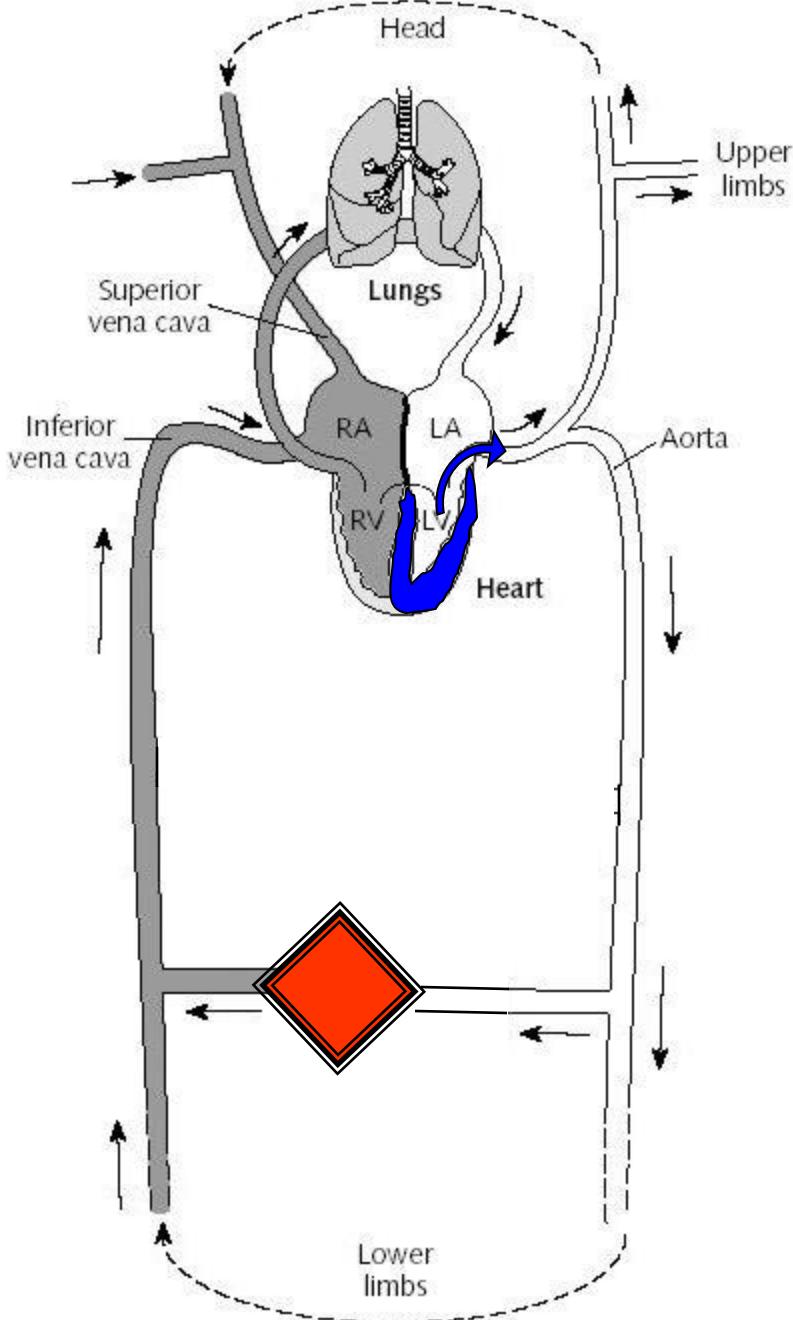
Oxygenation

Cardiac assistance

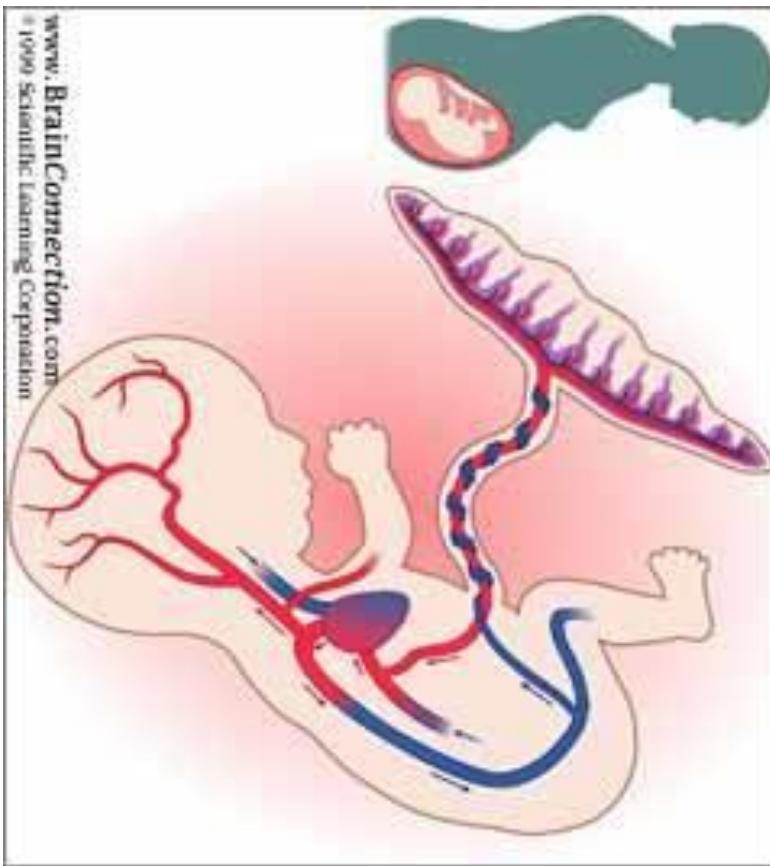


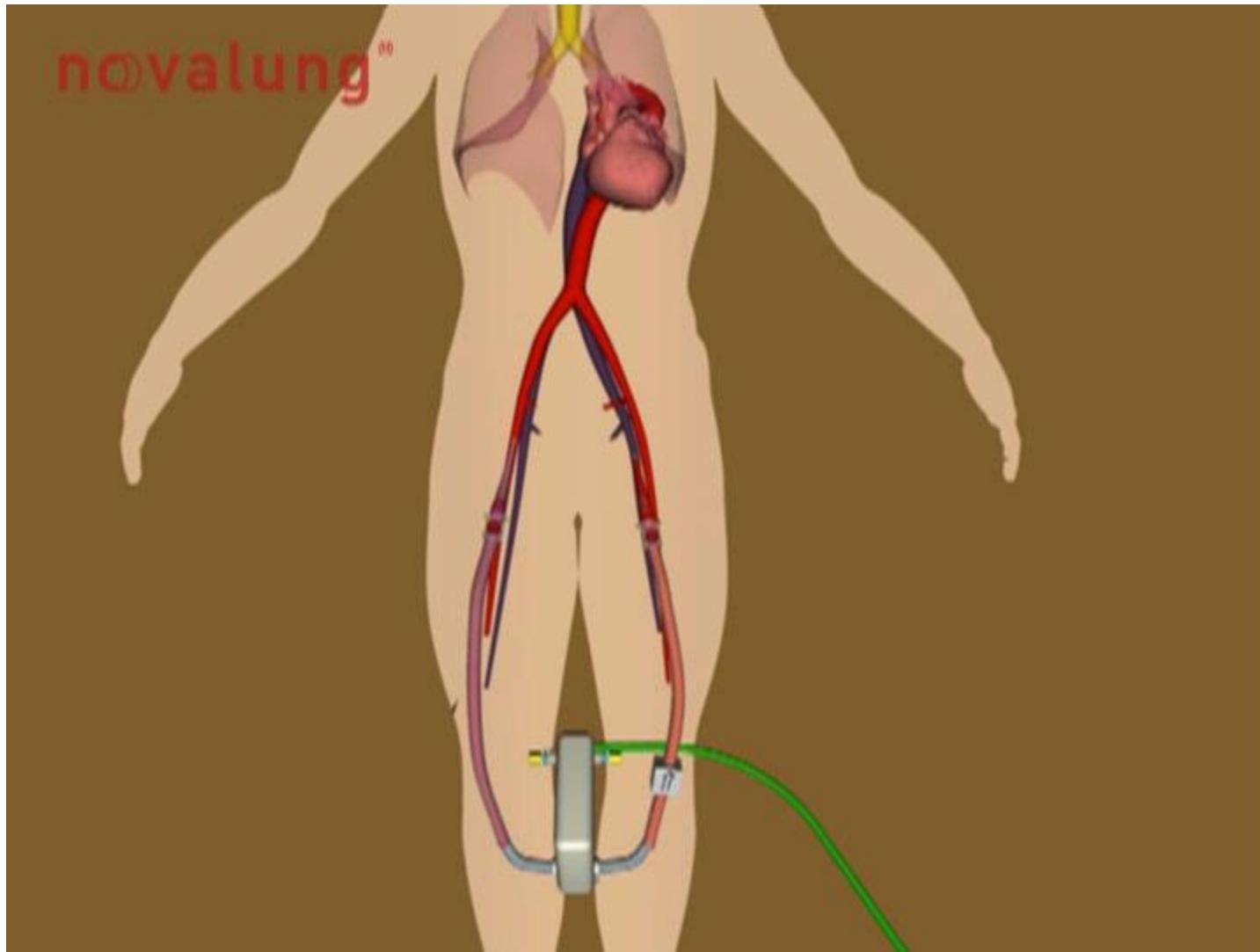
av ECLA pumpless (ILA Novalung)

CO₂ Removal



A placenta on the adult circulation





ECMO 2

Oxygenator

hollow fibers (gas inside, blood outside)

continuous polymethylpentene membrane (no
micropores)

thrombo-resistant coating

low volume

low resistance



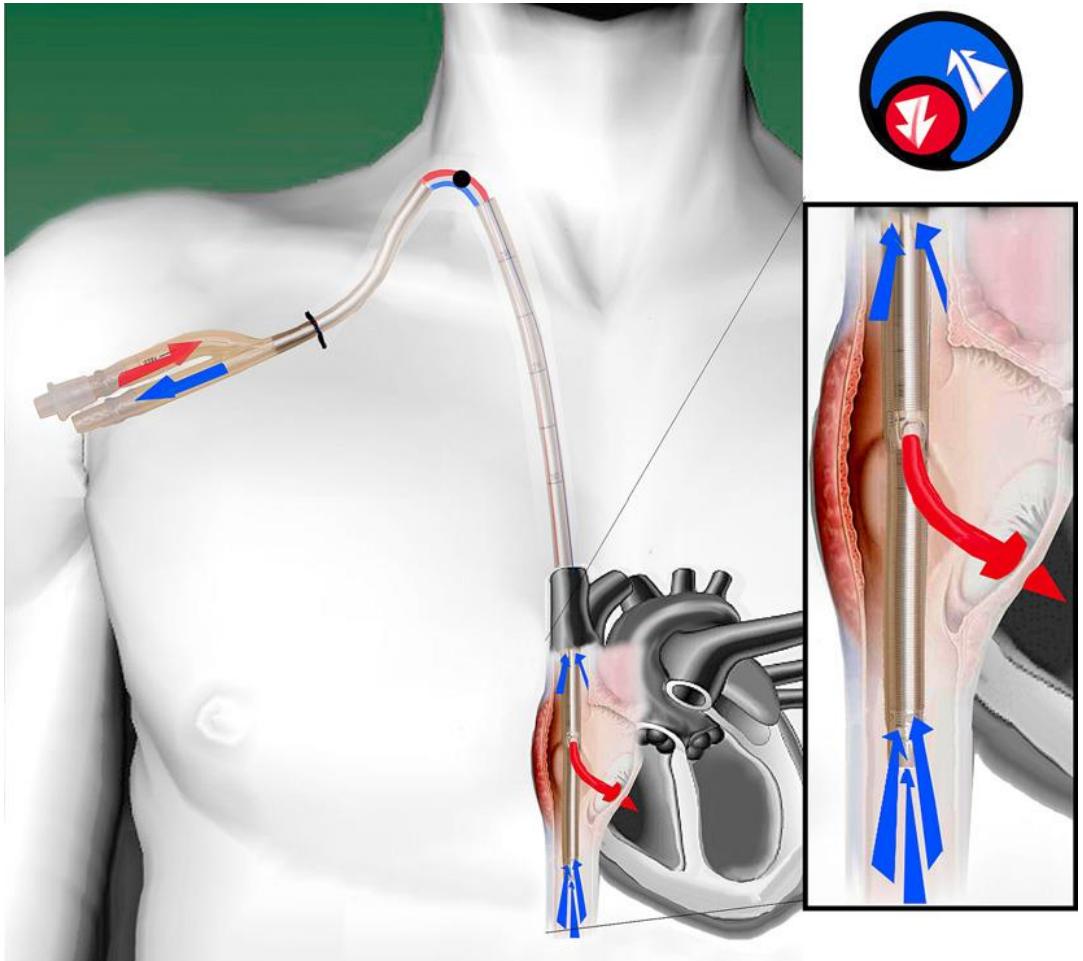
ECMO 2

Circuit

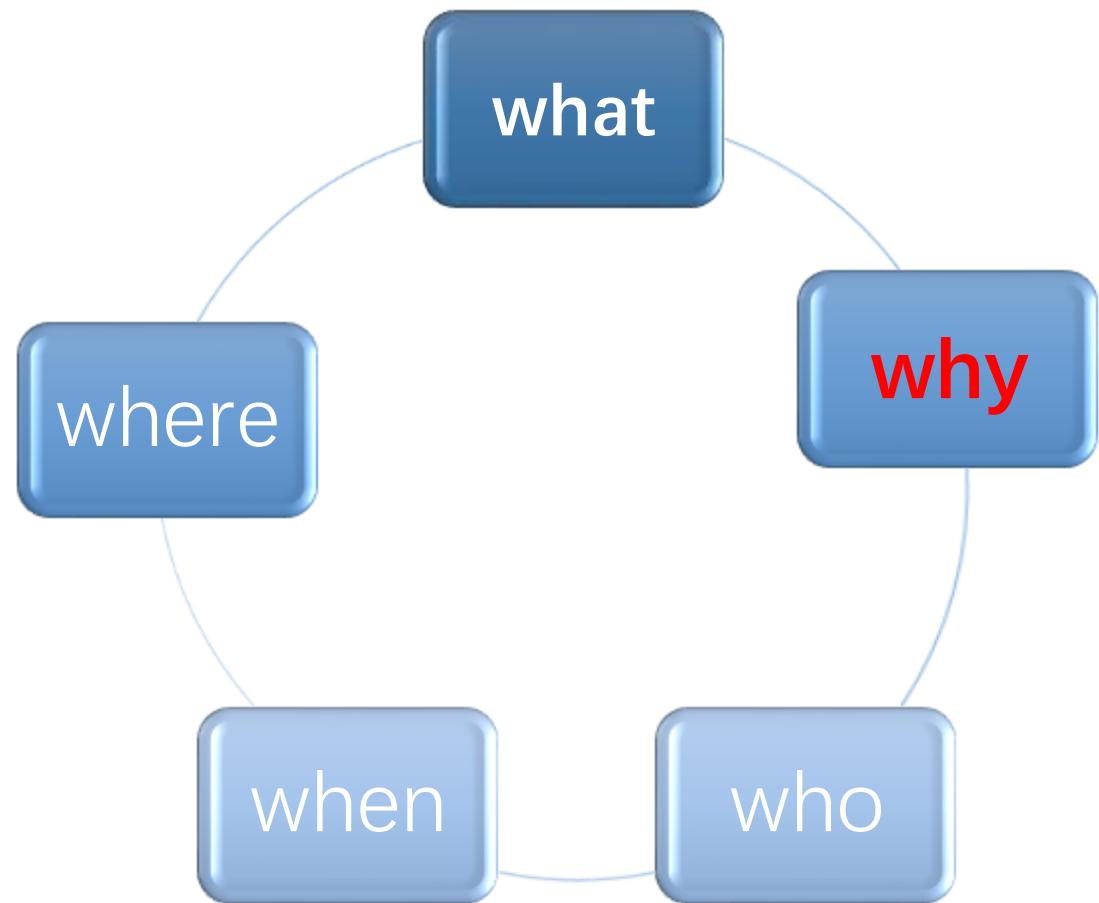
- heparin-coated

Cannulas

- peripheral
- percutaneous
- heparin-coated
- even bilumen



内 容



Why we need ECMO

- support organ function for patients with reversible diseases until it recovery
为可逆疾病提供器功能支持和恢复时间

- extend end-stage patient' s lives as possible until ready for traplantatoin
为不可逆疾病创造等待移植的机会

buying time from GOD
用金钱向上帝买时间

ECMO到底给我们带来什么？

faith
1911



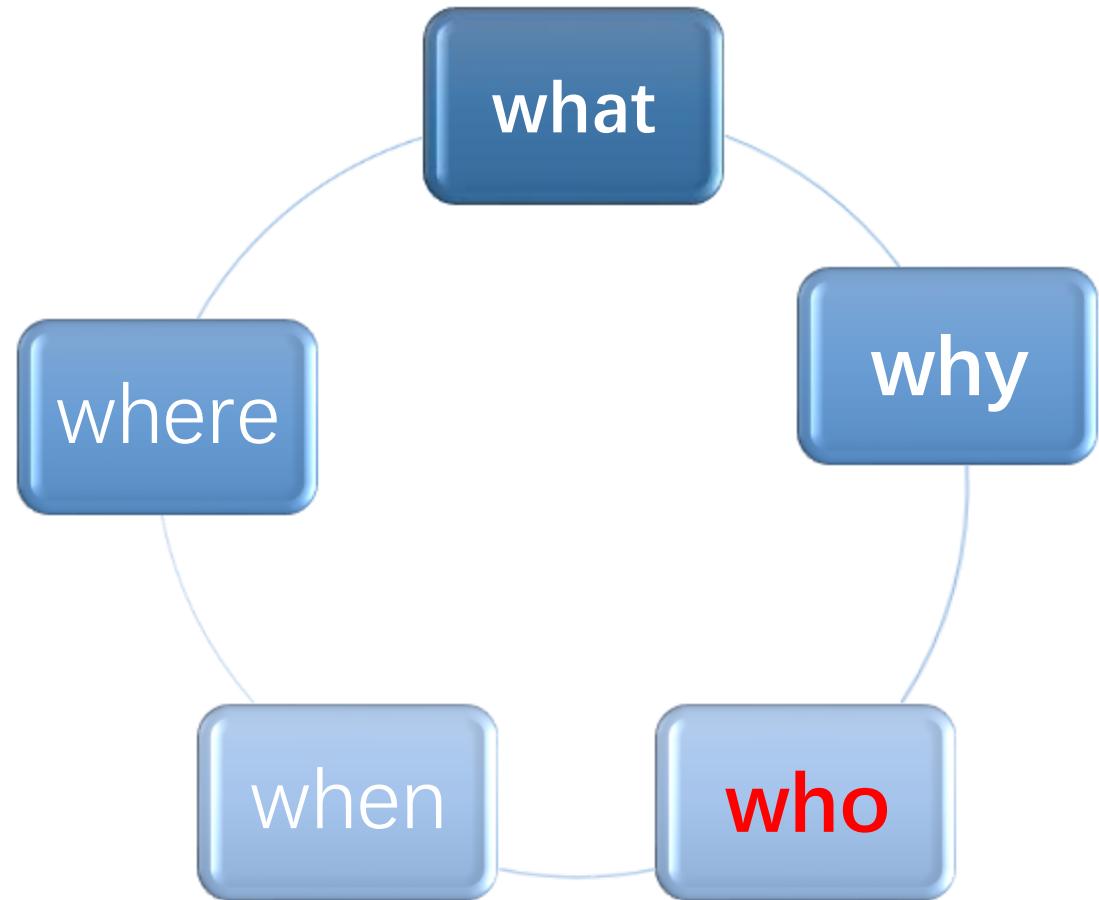
Never
Surrender

- 面对生命
- 我们永不言弃

Who need ECMO

所有心肺功能不全

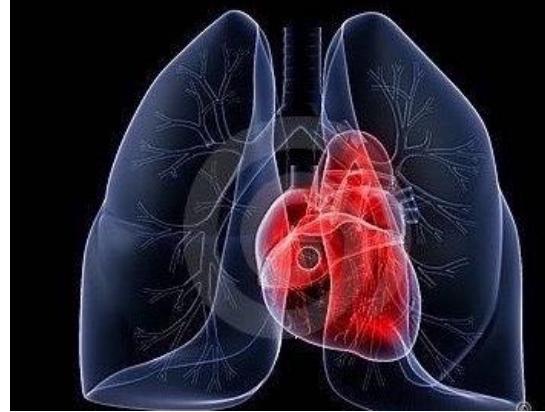
内 容



Who need ECMO

- keep organs perfusion
- await heart or pulmonary function recovery
- await transplant
- donation

ECMO Veno-arterial



- Inadequate tissue perfusion manifested as hypotension and low cardiac output despite adequate intravascular volume.
- Shock persists despite volume administration, inotropes and vasoconstrictors, and intraaortic balloon counterpulsation if appropriate
- Typical causes: Acute myocardial infarction, Myocarditis, Peripartum Cardiomyopathy, Decompensated chronic heart failure, Post cardiotomy shock
- Septic Shock is an indication in some centers.

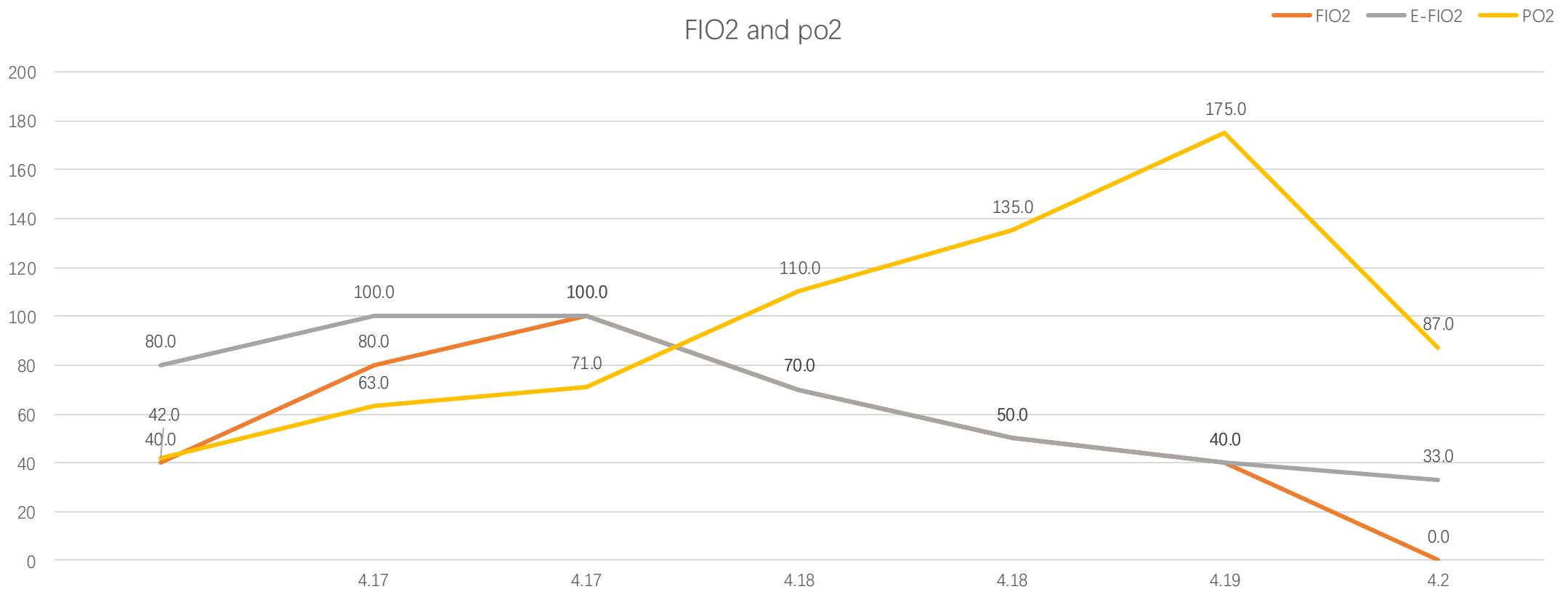
case 1

- male, 30yrs,
- 3 days fever, 1 day dyspnea
- 3 days before, got fever, the highest temperature was 38.9, accompanied by cough, spurum
- chest CT scan in local hospital showed :bilateral pulmonary infection.
- presented type 1 respiratory failure sharply. treated by non invasive mv one day. then shock, cTnI >300.
- transfer

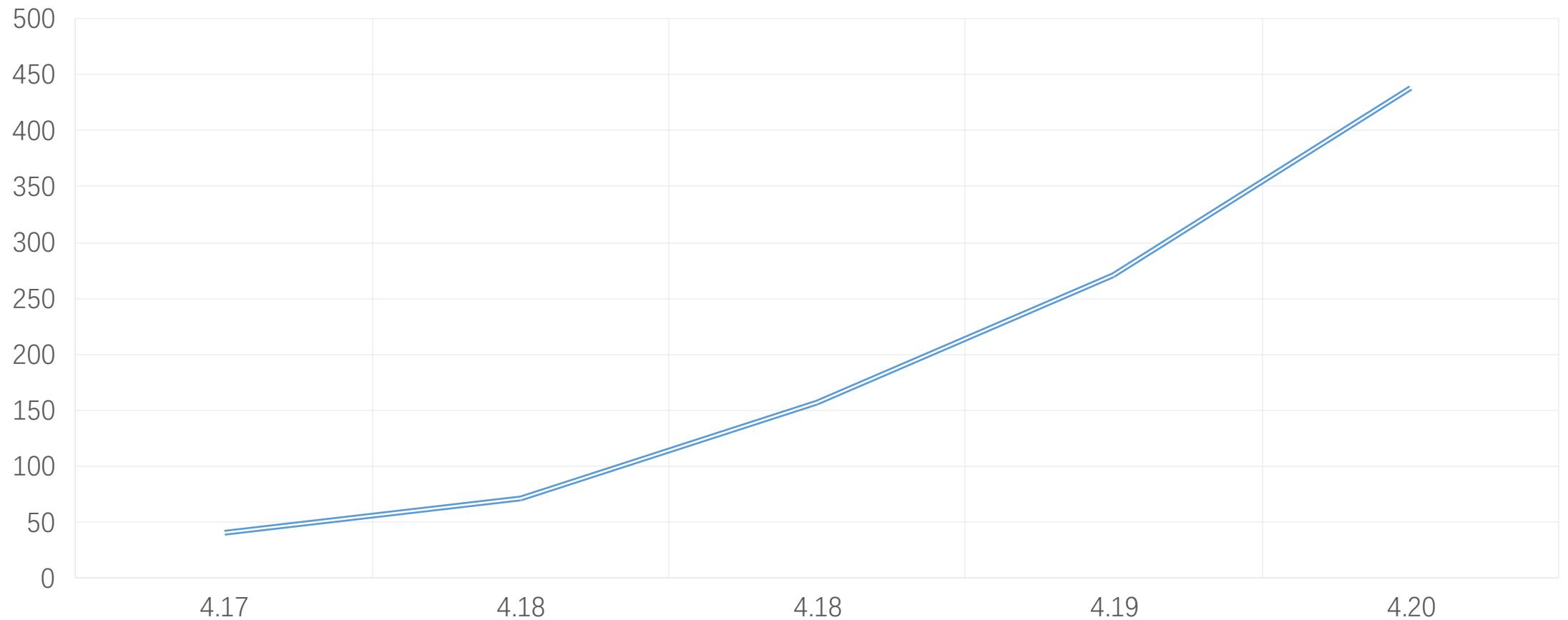
6:30AM - 7AM - 9AM - 11AM

- 6:30AM in the ICU
- T 37.5, HR 132bpm, R 33bpm, BP 98/60(NE pump) , SPO2 88%(on O2 12L/min, reservoir mask), He was agitated, lung auscultation revealed coarse and moist rales along with ventricular gallop sounds
- About half an hour later, he fell into a coma, with HR shot up to 190bpm, BP dropped to 75/50mmhg, SPO2 was down to around 78%, experiencing dyspnea with RR about 45bpm
- He was intubated,, and his Bp kept dropping despite massive doses of inotropes being used.
- We start continuous renal replacement therapy and initiated VAECMO

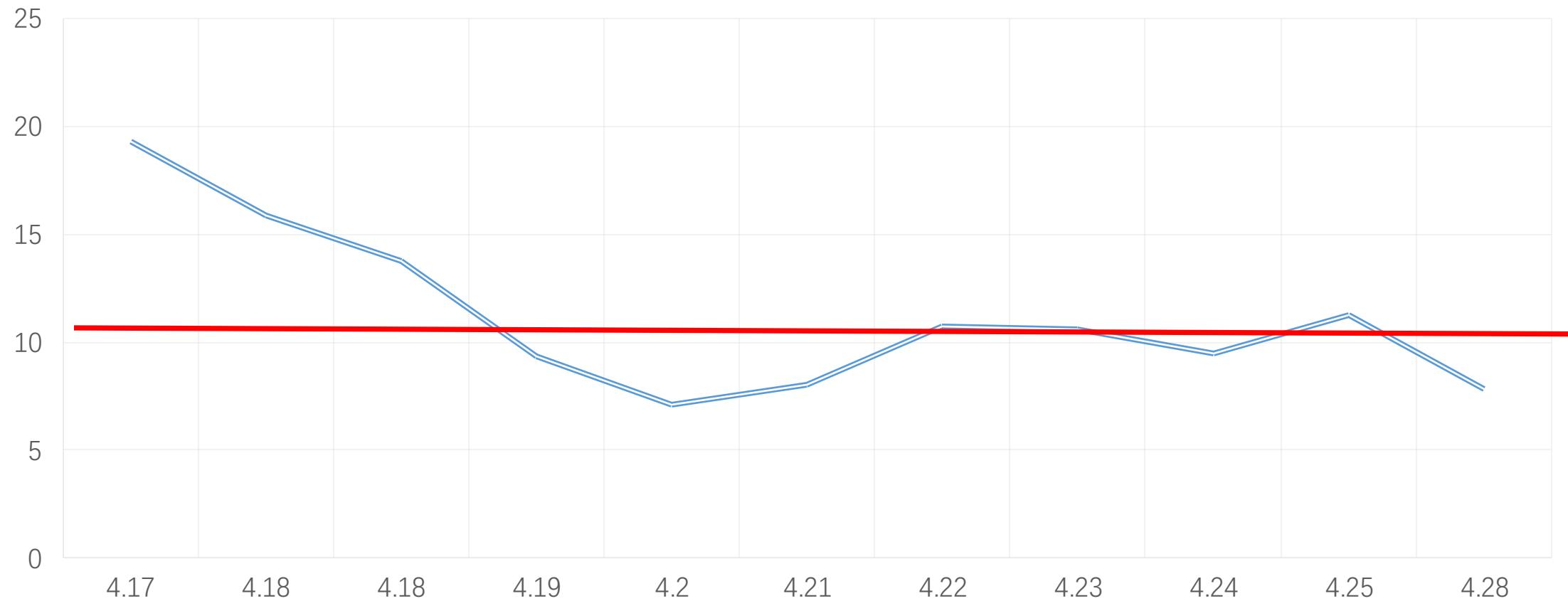
FIO2 and po2



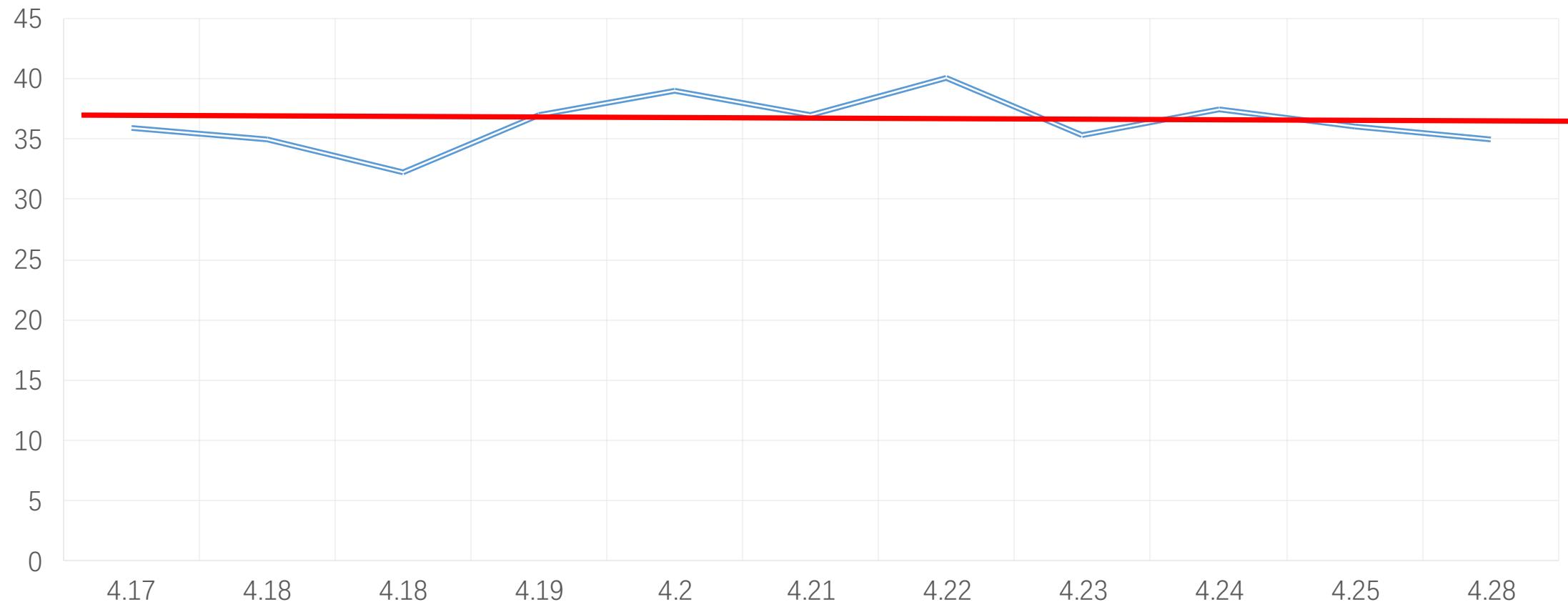
P/F RADIO TRANDS



WHITE BLOOD CELL

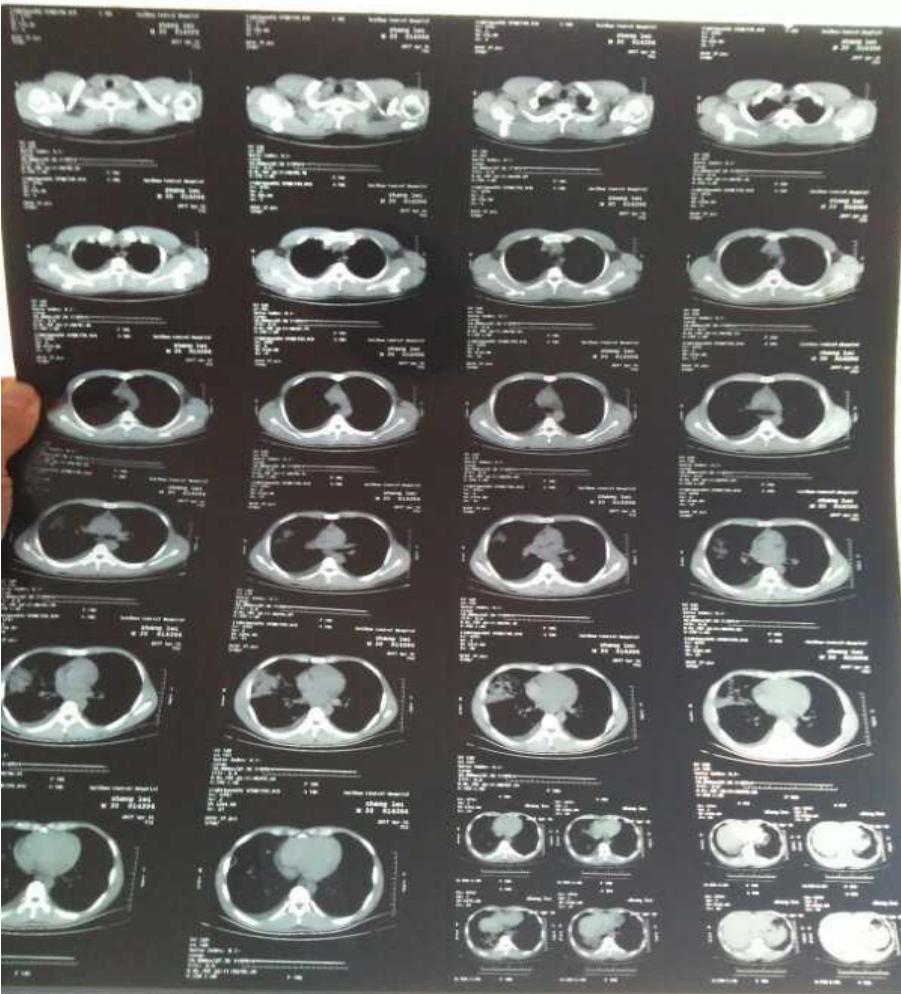


HCT趋势图



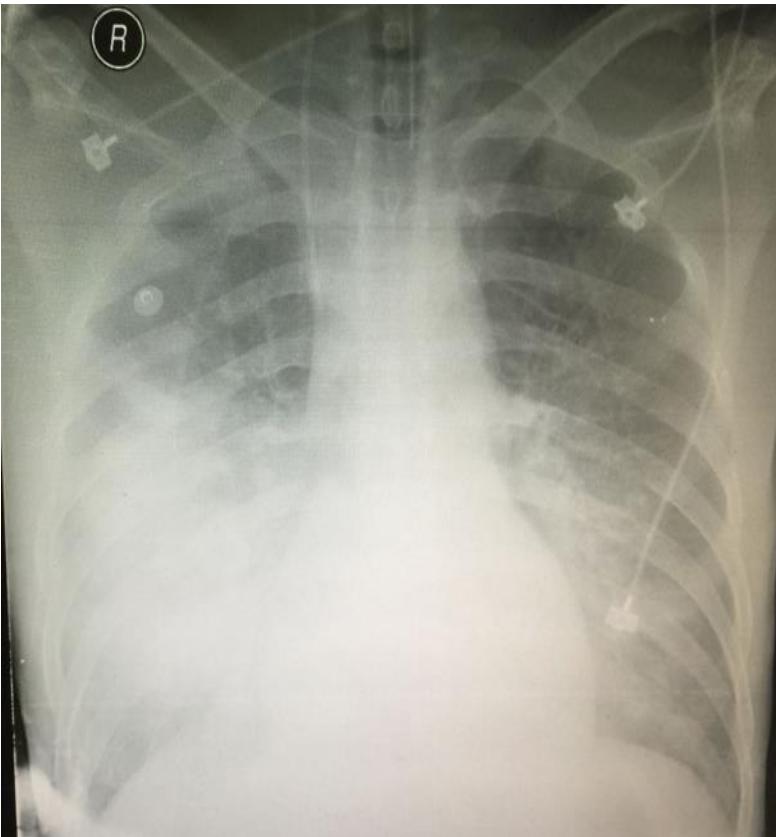
	4.17	4.18	4.19	4.20	4.21	4.22	4.23	4.24	4.25	4.28
WBC	19.31	15.9/13. 79/9.3	9.36/9.4 1	7.08	8.03	10.71	10.61		11.26	7.85
NE	84.7	90.6- 91.9	90.1- 87.6	87.4	76.1				76.9	62.9
HB	132	126-108	121	123	133	137			130	122
HCT	35.9	35/34.8/ 30.3	32.2- 35.3	37	39		40.1		37.5	36
lac	1.75	1.12/1.7 5	1.32- 1.11	0.96	0.96	0.6	0.66	0.71	0.53	
PO2(fio2)	40/1.0	71/1.0	110/0.7	135/0.5 +0.5	175/0.4 +0.4	87				
BNP	9387	10677	4798	2907	2347	1845	1675	768	630	264
cTNI	21127	4084	5132	3965	2930	3070	2274	1318	932	173
inotrops	DA/DF /NE/P	DA/DF	DF	GLY/NP	Stop ECMO	Stop MV	MRCNS(blood)			
T	39.2	不升	不升	39.6	38	normal				

chest CT scan

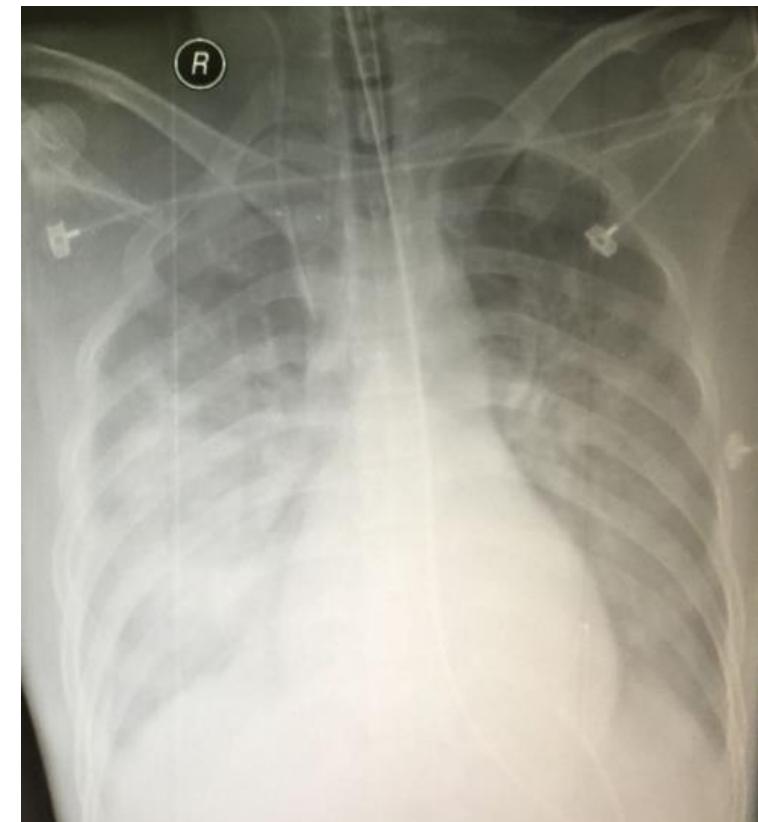


bedside chest ray

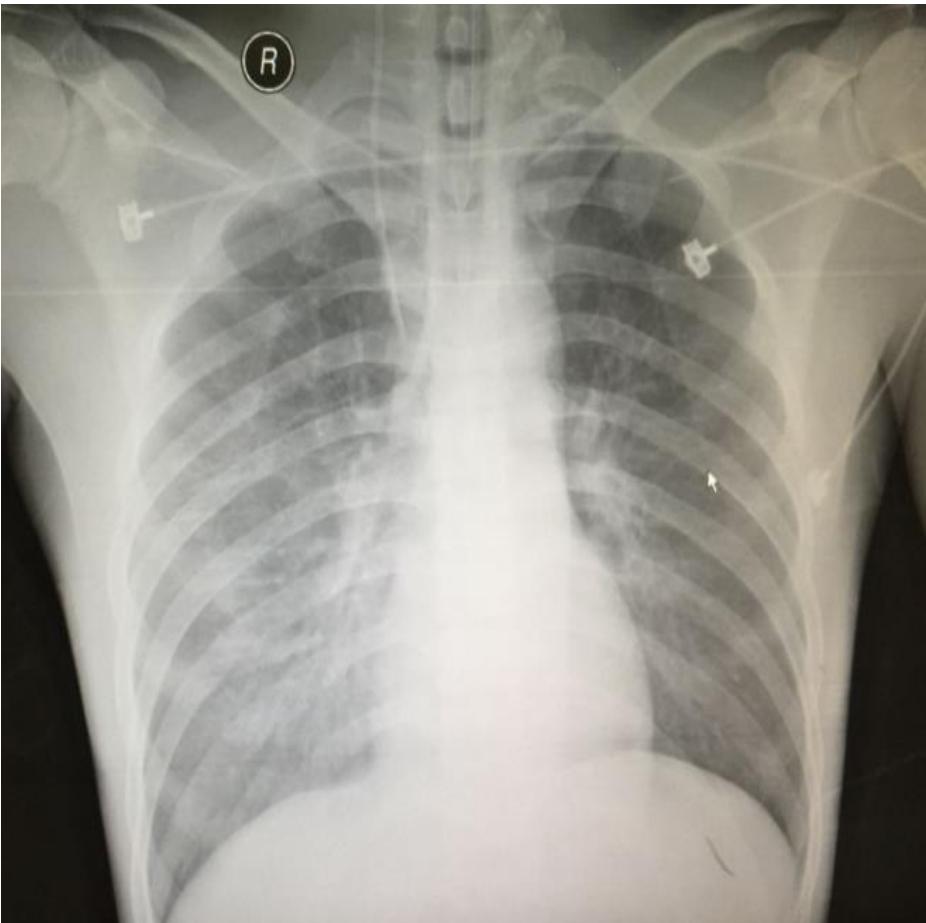
after ECMO 2h



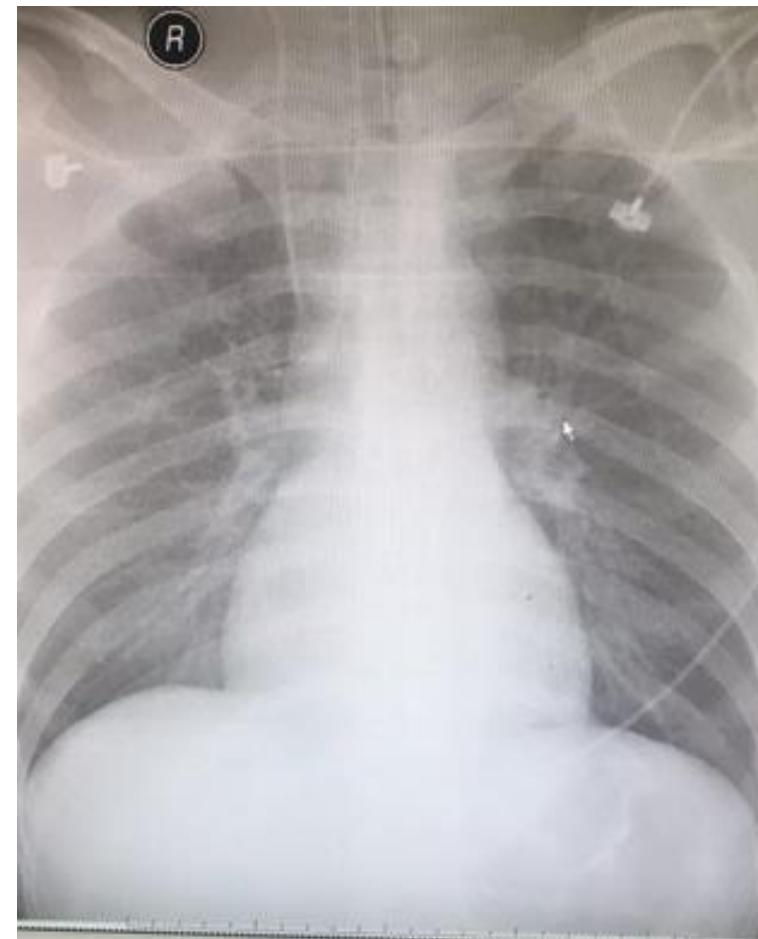
24h

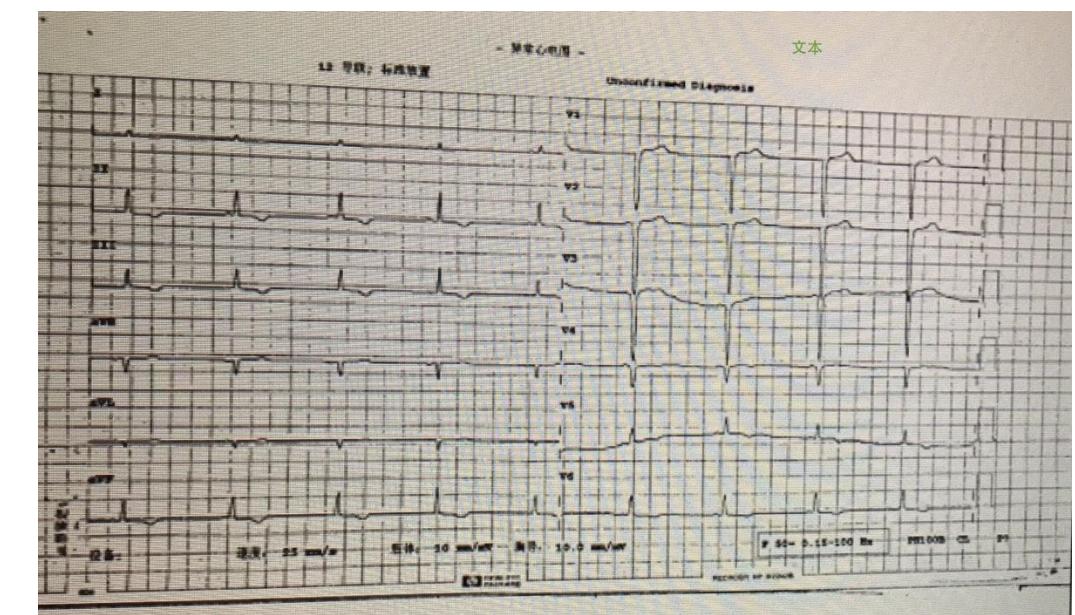
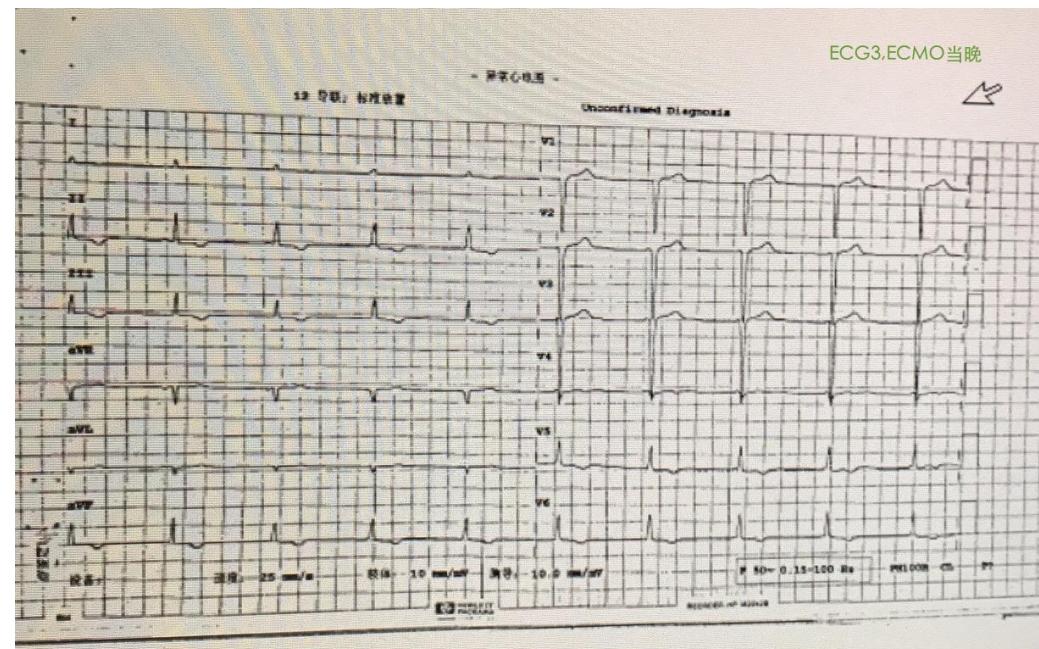
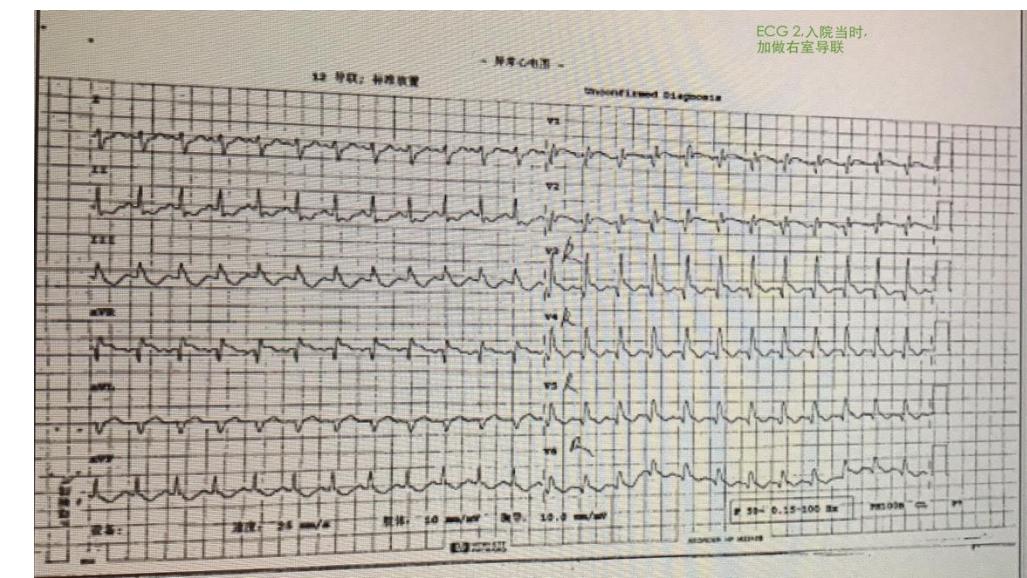
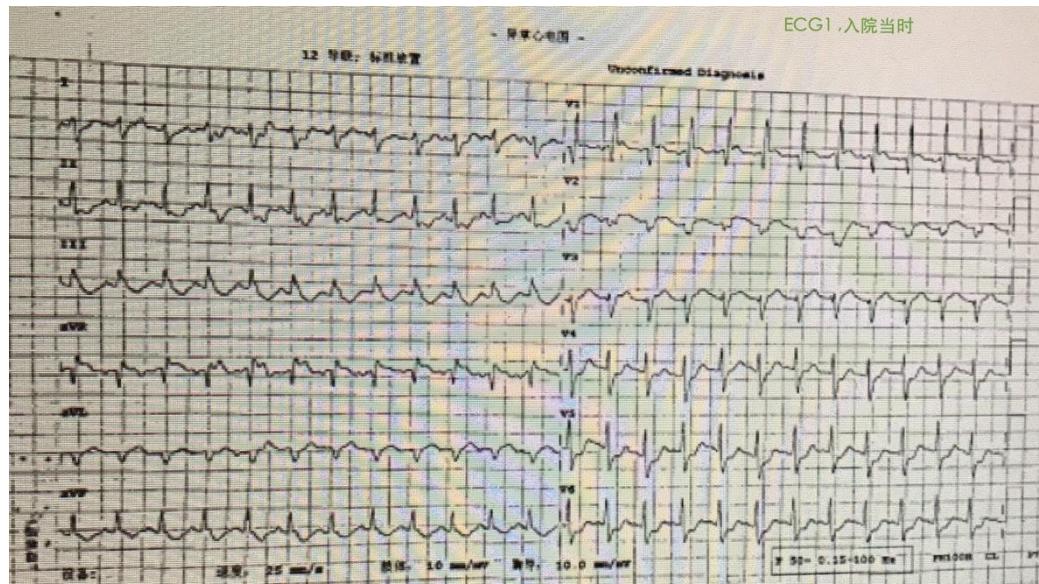


72h

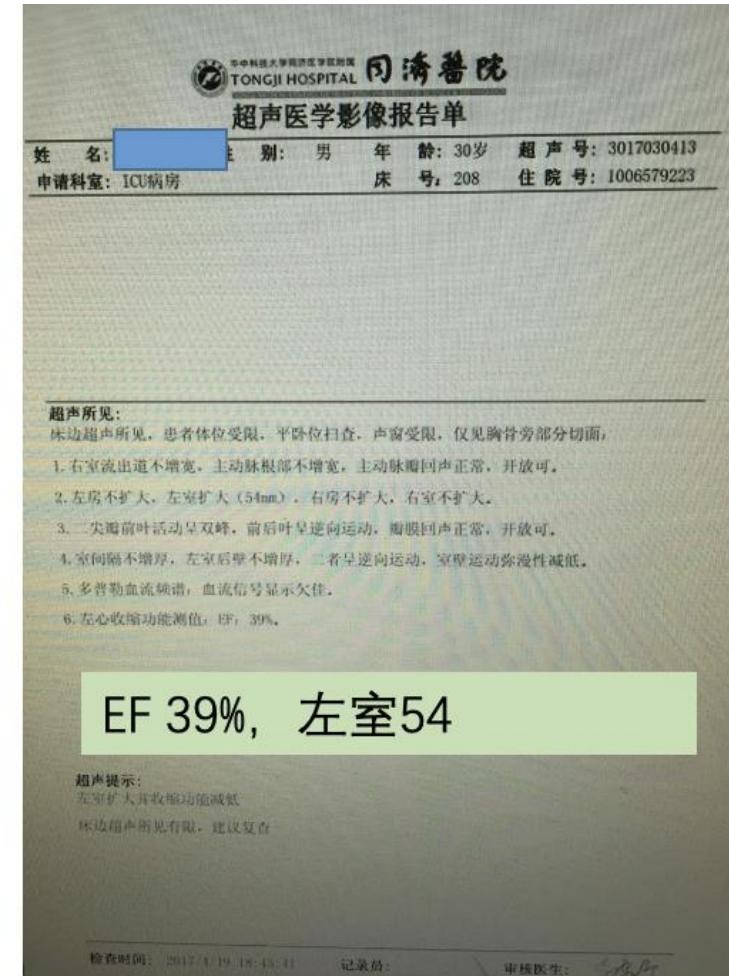
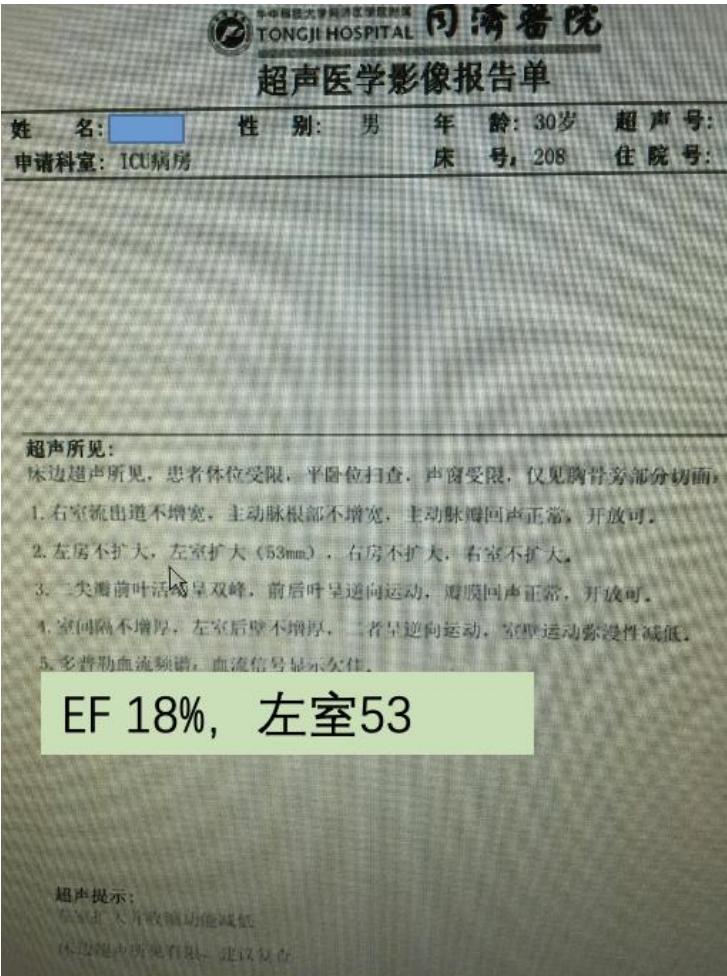


quit



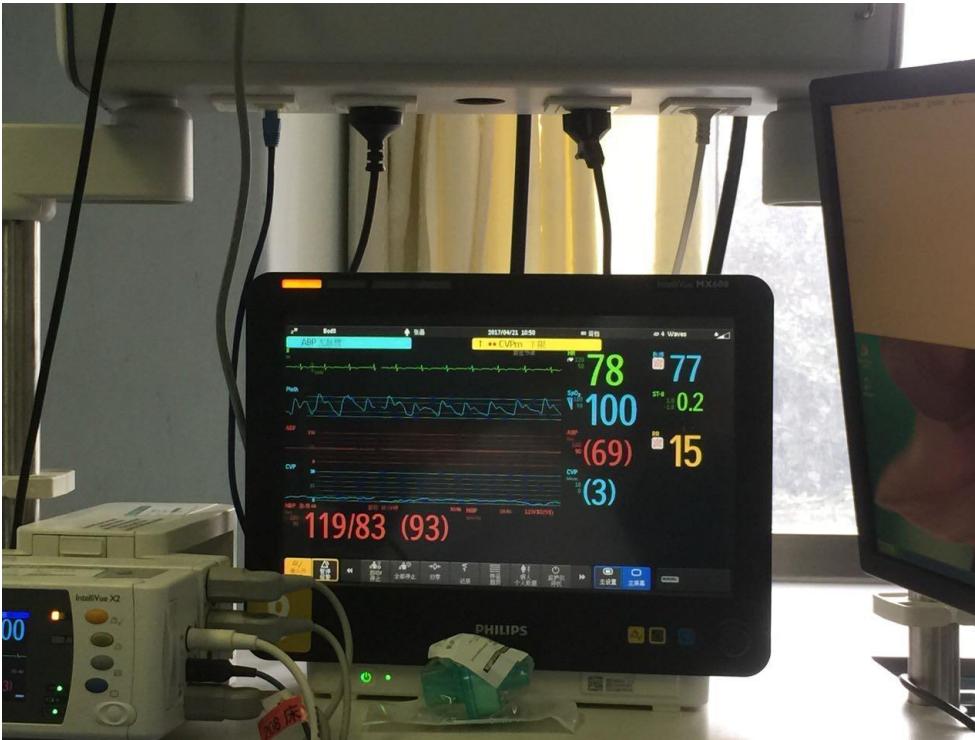


UCG

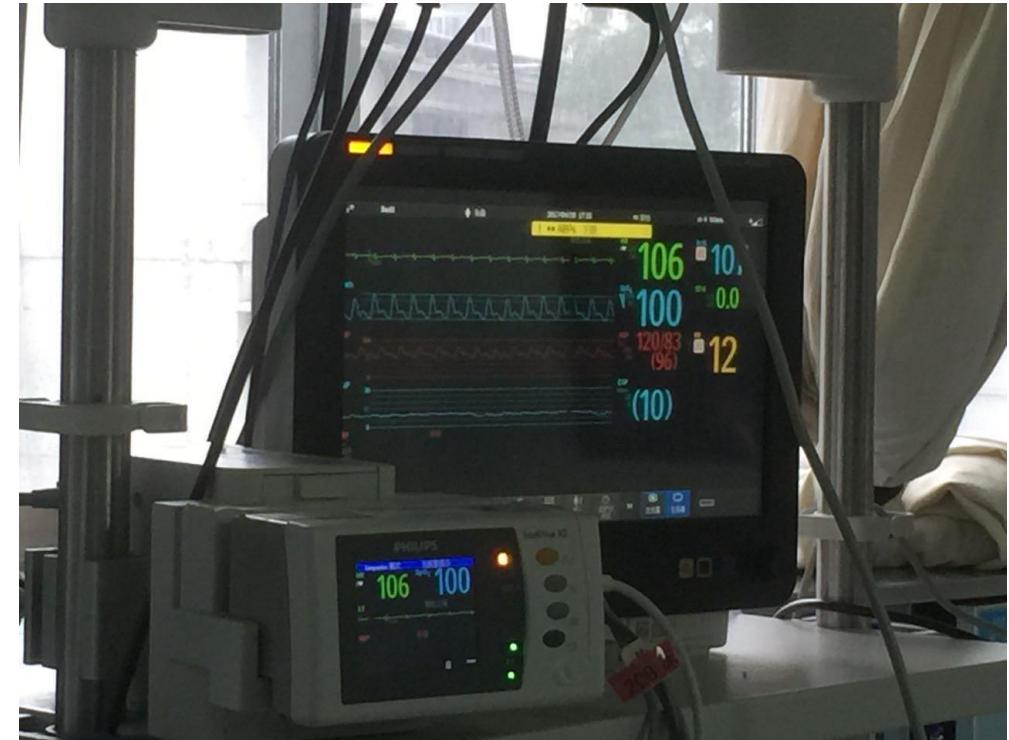


MONITORS

24h (18/4 morning)



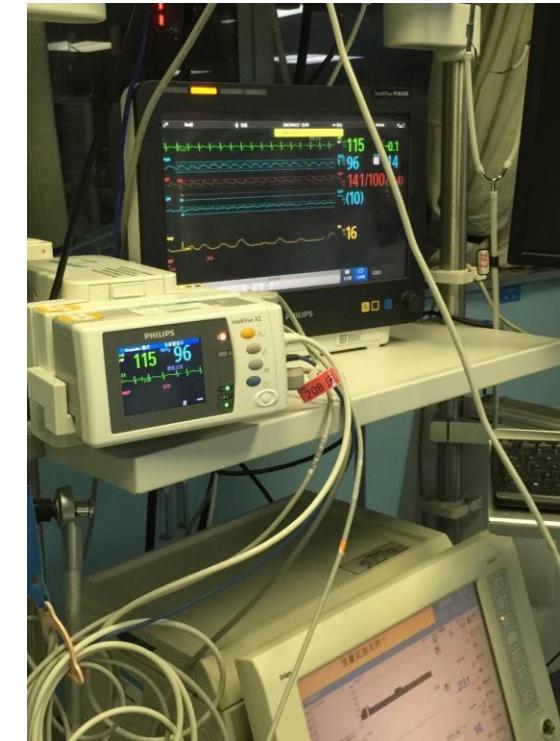
48h (19/4)



72h (20/4 morning)

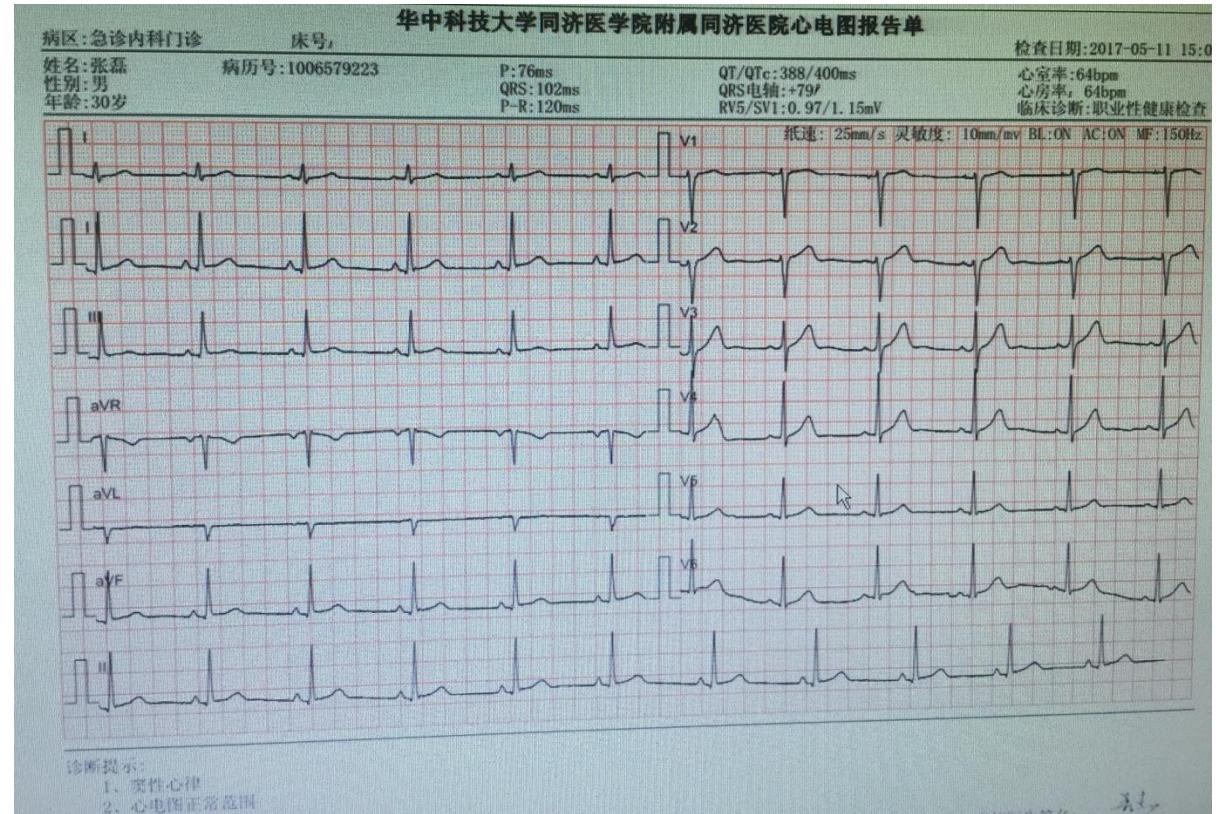


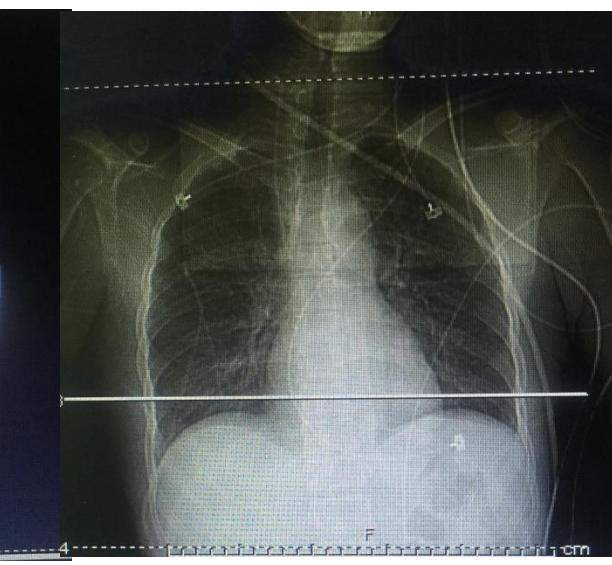
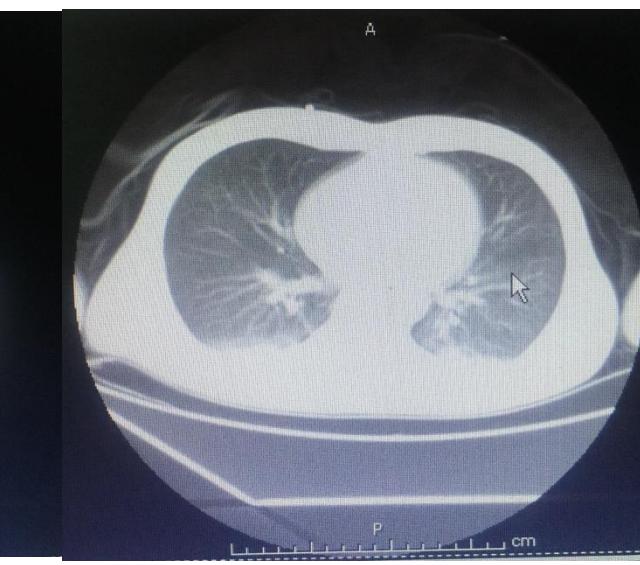
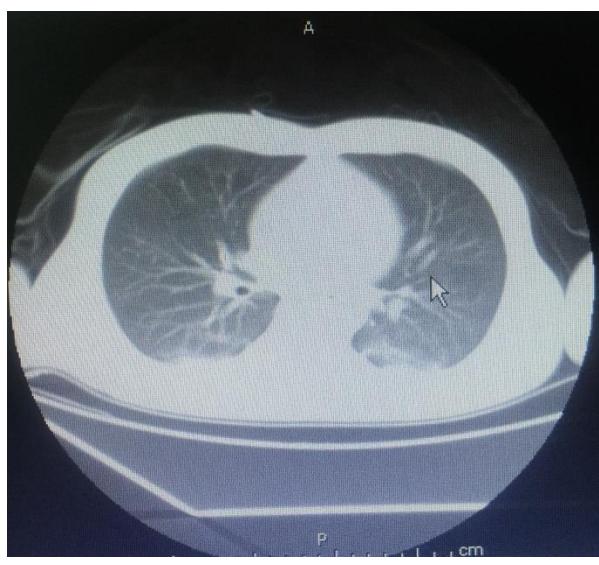
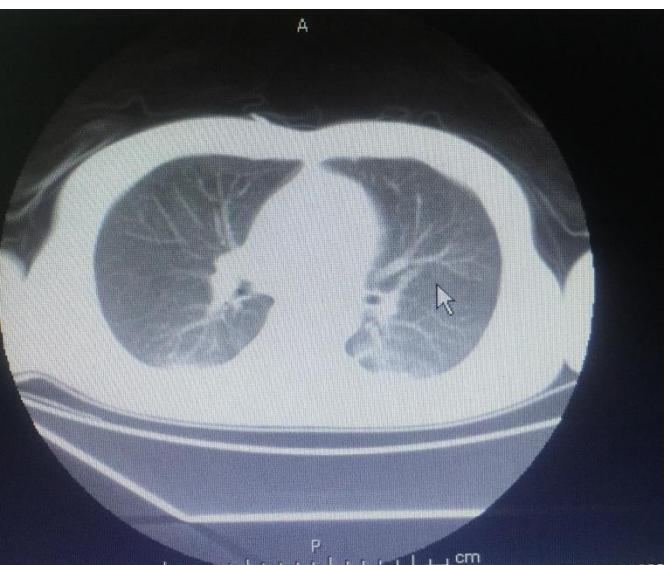
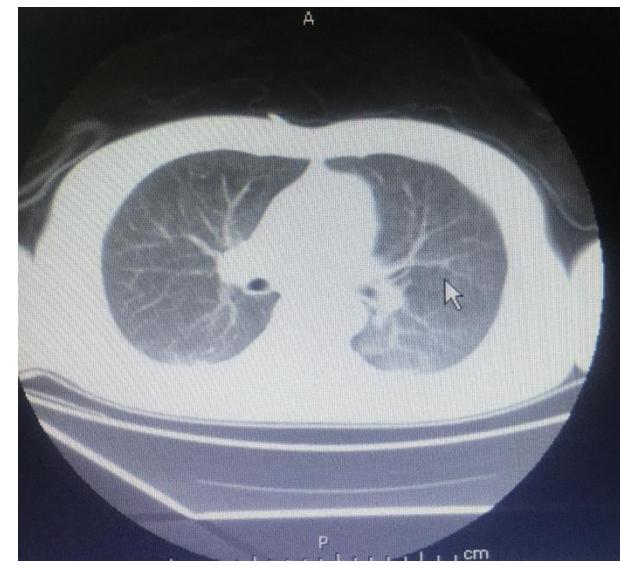
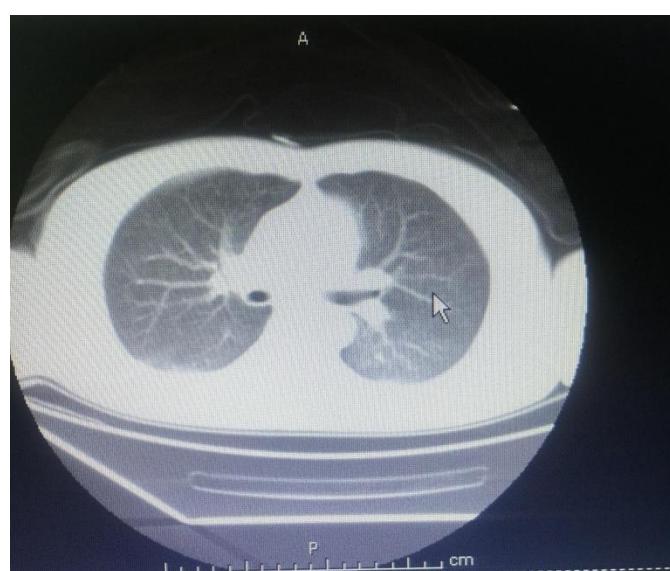
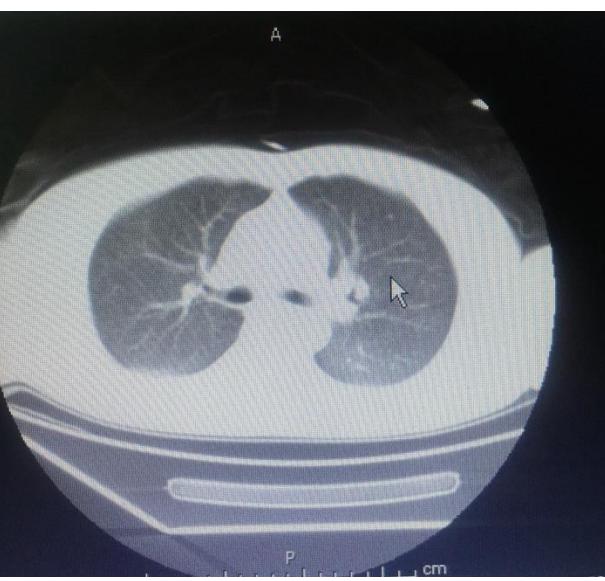
90h (20/4 evening)



one month after discharge

- without uncomfortable
- chest x ray :normal
- UCG: normal
- ECG: normal
- all lab tests came back fine!





ECMO veno-veno



- Bridge to LTx
- Acute respiratory failure:
 1. **Rescue treatment** (including **safe transport**) of pts with severe hypoxemia and/or hypercapnia
 2. **Complement to Invasive Mechanical Ventilation**, to allow protective lung ventilation in difficult cases
 3. **Alternative to Invasive Mechanical Ventilation**, to avoid intubation

Respiratory ECMO

- **vvECMO** is the technique of choice in most of cases
- if results indeed are so good, why not to extend the indications?
 - costs
 - complications

case 2

- A 61-year-old man
- presented with productive cough, progressive dyspnea, and four-days fever.
- ABG showed PO_2 43 mmHg at reservoir mask, 12L/min. Patient was admitted with a diagnosis of acute respiratory failure to ICU,
- then immediately intubated for severe distress, the hemodynamics deteriorated and norepinephrine was used to maintain adequate blood pressure.
- At the time of admission to the ICU, the Murray score was 3.75.

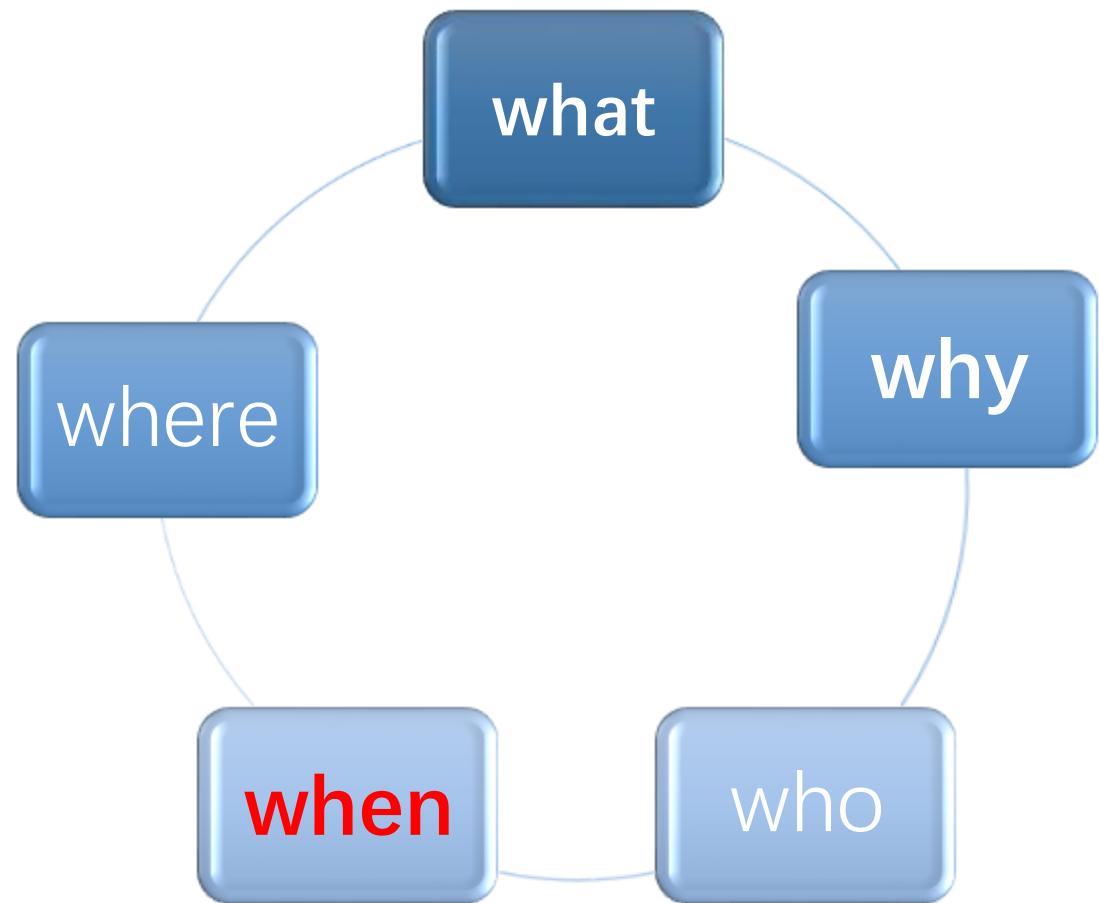
case 1

- After 4 hours a VV ECMO was established(airflow 5L / min, bloodflow 4.5 L / min, FiO₂ 1.0) and a EVLW monitoring started by PICCO.
- Oseltamivir and CRRT were given.
- EVLWI decreased from 42ml/kg to 24ml/kg, while P/F ratio improved from 60 to 275 until the ECMO be forced to stop at 5th day.
- The patient was discharged to local clinic to continue MV for 4 days, then extubated successfully.



items	1/20	1/21	1/22	1/23	1/24
EVLWI(ml/kg)	42	48	33	28	24
PO ₂ (mmHg)	87	72	95	151	113
FiO ₂	0.7	0.7	0.6	0.55	0.45
ECMO-FiO ₂	1.0	0.9	0.8	0.7	0.6
Cl(l/min/m ²)	3.3	3.27	4.01	3.83	3.94

内 容



When we should give vvECMO

- hypoxemic respiratory failure
- hypercarbic respiratory failure
- respiratory failure in lung transplant
- bronchopleural fistulas and pulmonary air leaks
- complex airway management

details about hypoxic

ELSO

- P/F **<150** on **FiO₂ >90%** and Murray score **2-3**
- P/F **<100** on **FiO₂>90%** and Murray score **3-4** despite optimal care for **6h** or more

French Eolia Trial

- P/F **<50** with **FiO₂ >80% for 3h**
- P/F**<80** for **6h**, PH 7.25 for 6h

Contra-indications

- MV on high settings for
>7days
- limited vascular access
- septic shock?

irreversible conditions

- metastatic cancer
- brain injury
- contraindication to use of anticoagulation
- inability to receive blood
- high body mass index >45
- **major immunosuppression**

When we should give vaECMO

CI<1.8lpm/m²



LAP或PCWP>20mmHg

SBP<90mmHg

MAP<60mmHg

urine op<20ml/h

metabolic acidosis

SVRI>2100

所有常规治疗

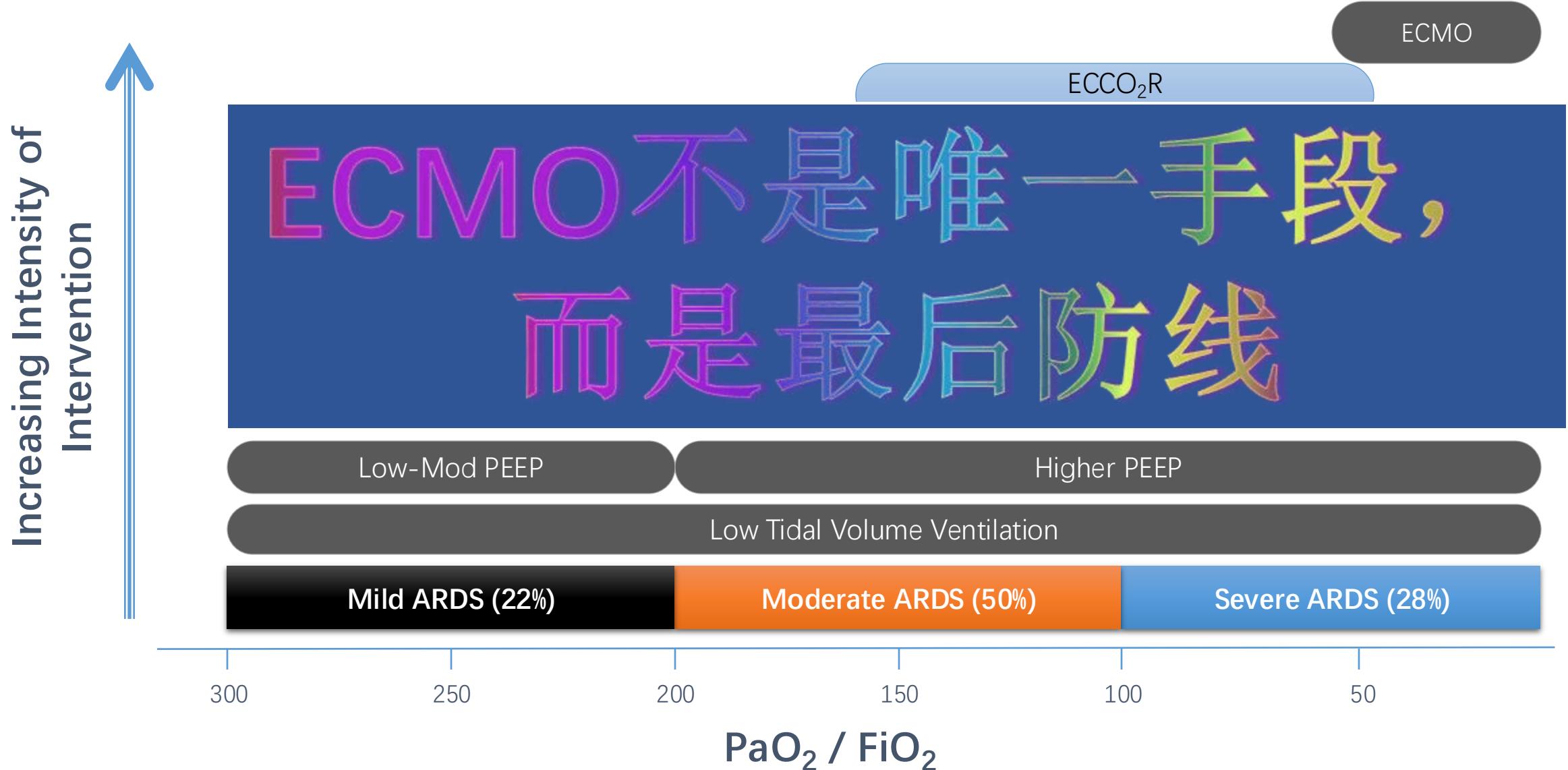
所有未明确诊断

无后续措施

不能明确获益

施

慎！ 慎！ 慎！



内 容



Where we can do ECMO

ICU与急诊室



Where we can do ECMO



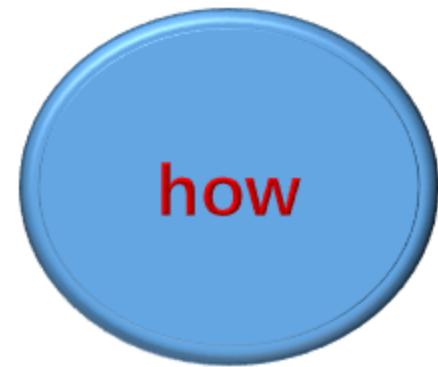
导管室与手术室

Where we can do ECMO



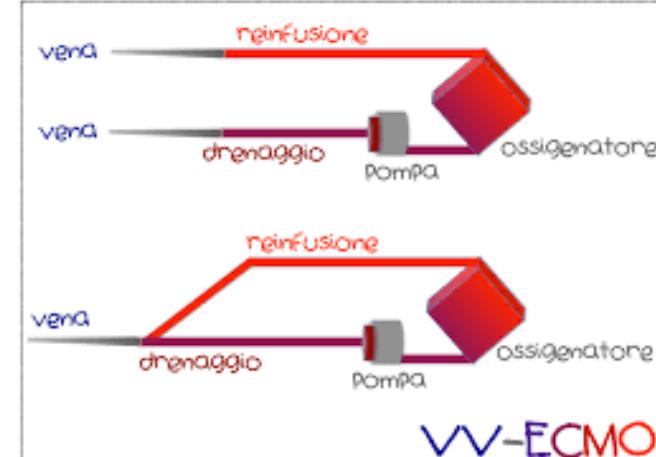
急救转运

内 容

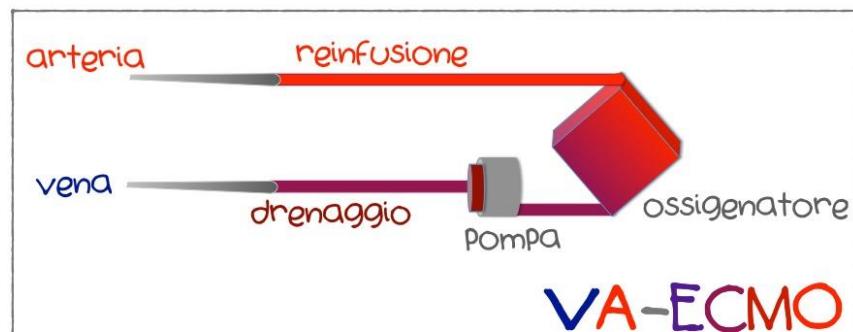


How to do ECMO

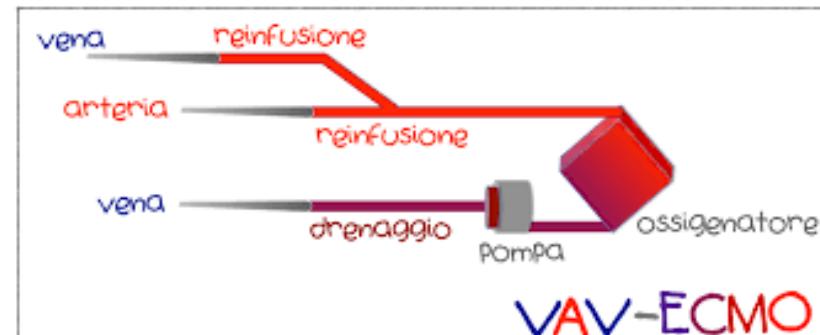
VV ECMO



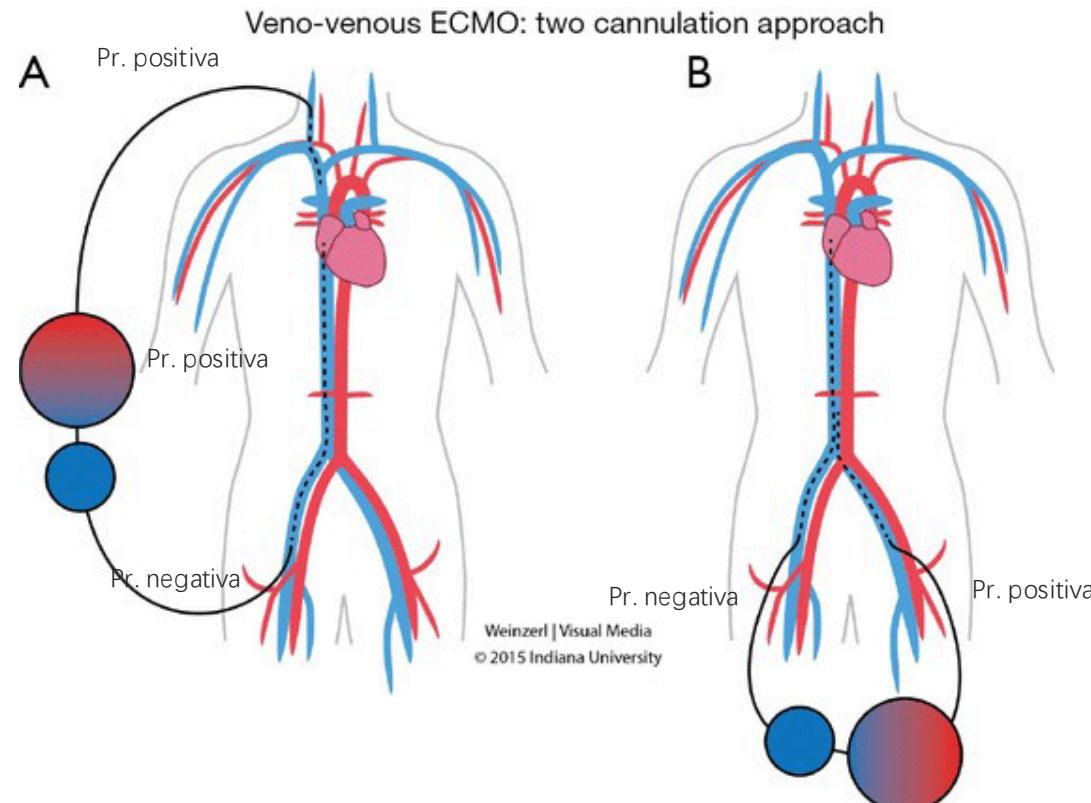
VA ECMO



VAV ECMO

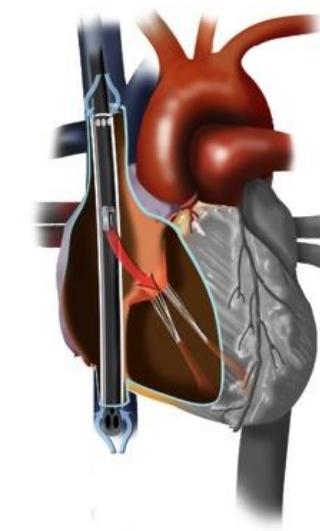
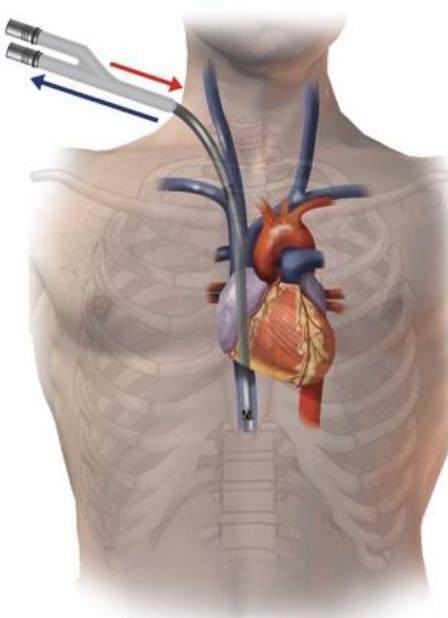
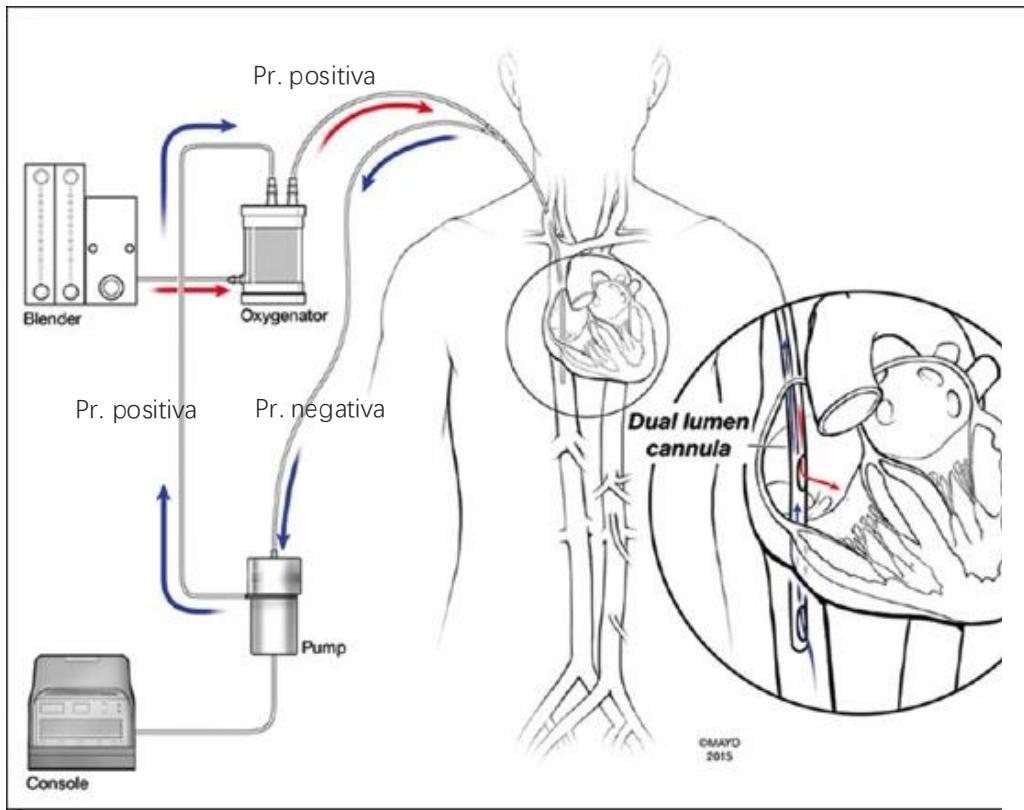


Vv ECMO

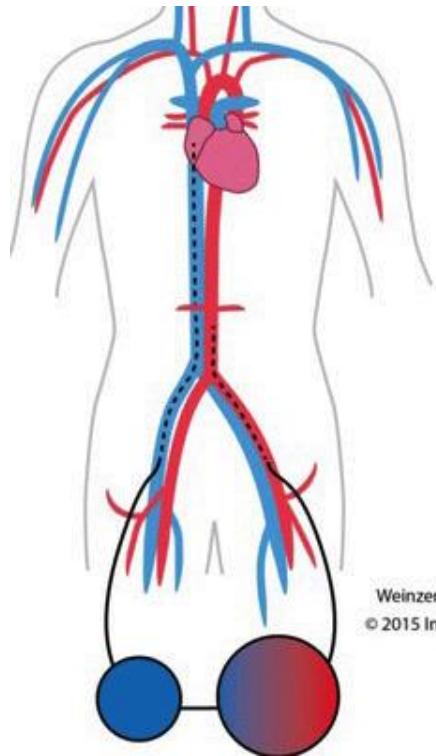


Femoro-jugular

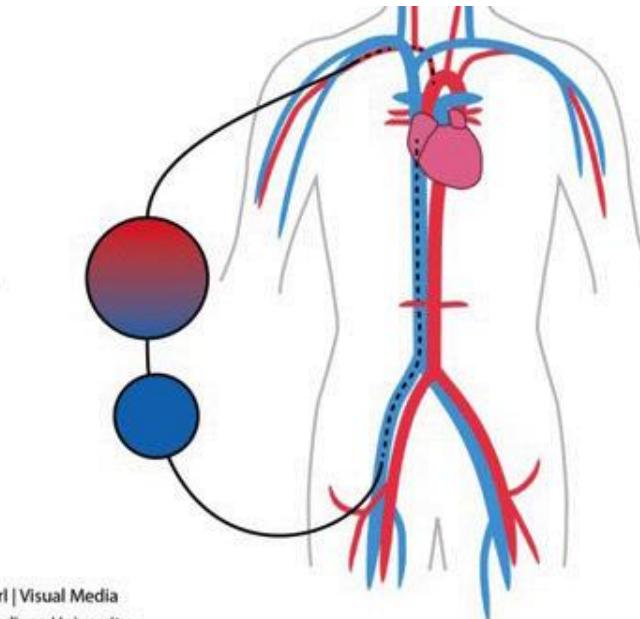
Femoro-femorale



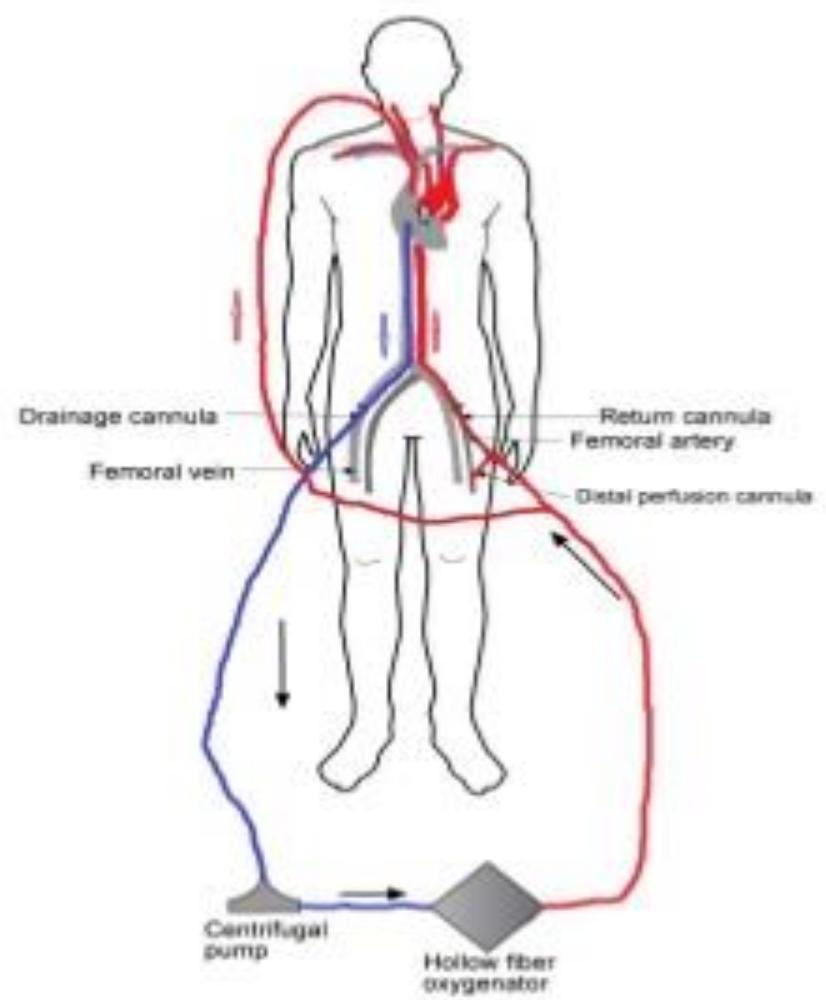
Va ECMO



Femoro-femorale



Femoro-subclavian



Special for you all

Type	Extracorporeal CO ₂ Removal	Full ECMO	
	 	  	
Vascular Access	Veno-Venous Single catheter 15 Fr Double-lumen	Arterio-Venous Two catheters A: 13 Fr V: 15 Fr	Veno-Venous 21-32 Fr Double-lumen, or Two single lumen 15-24 Fr
Blood Flow	~ 250 – 550 mL/min	~ 1.0 L/min	2.0 – 5.0 L/min
CO ₂ Removal	Up to 40%	Up to 50%	Up to 100%
O ₂ Delivery	~ 10%	~ 10%	Up to 100%

ECMO is a project



education, collection, operation.....

thanks for you listening

